Mechanical World —— April 1958

Spot on—and Quickly

THE two attributes of speed and accuracy possessed by electronic computing equipment seem to promise almost universal application, but not because of one or the other attributes; it appears to be the combination which makes for success.

Take the P1 fighter for example. From what was said in the House of Commons by Mr. Ward, the Secretary of State for Air, the pilot of the P1 will provide the directing brain behind what is in effect a computor-guided weapon. Now the P1 is extremely fast, and in action it is making for a target which is also travelling at high speed. The time available for making calculations is thus bound to be short, very short, and only an electronic apparatus can offer the calculative speed required. At the same time, the target is insignificantly small in the expanse and depth of the sky and to find it, say, from a continuous flow of position data, requires a degree of accuracy almost as hard to appreciate as the scale of infinities. The satisfaction of both requirements is, however, well within electronic capability.

A very different set of circumstances is the use of electronic equipment for accounting. The assurance of accuracy is here readily appreciated. Where the speed is useful is, firstly, in the large volume of routine work that can be absorbed, and, secondly, in the speed with which results can be produced. The time is reduced from days or weeks to minutes or hours. This means that large volumes of clerical work can be done accurately and be presented promptly; and not only that, but the accounting system can be amplified to include any amount of analysis and thereby assist control and promotion to any desired extent. Thus no matter how complicated the organization or how voluminous the data, analysis can be carried to the point where decisions can be well-founded on factual results, whereas previously they had to be hunches arising out of the feeling engendered by the business environment.

The application of computing equipment to machine tools is quite different. Here the pursuit of accuracy has reached a point where quantity production to close tolerances is well established and the computor has come along at the right moment. Its speed enables it to take control in circumstances beyond human capacity for perception and reaction. A valuable corollary is the facility which the computor lends to variability in manufacture. With machines designed to make use of its capabilities it becomes possible to direct the machine instead of setting it up. Admittedly the work-piece has to be put in place and fastened down, but instead of having to be marked off, cuts made and measurements taken, the machine works to instructions, cutting accurately in relation to reference planes. It used to be thought that making the one-off job was the antithesis of the production method, and lately that only exceptionally could it be made so accurately as the product from first-class tooled-up plant, but the prospect now is of machines which will take bulk material and shape it readily and speedily with the highest degree of accuracy.

Continuous processing in its most modern form is practically ready-made for computor control. This is true irrespective of the product and providing only that the process is continuous. Processes as different, for instance, as chemical manufacture and motor car assembly are immediately subject to instantaneous and completely continuous control irrespective of the number of variables and providing only that the variables can be measured. With this access of capability it is not surprising that there is so much activity at present in the development of instruments for measuring variables.

The examples we have discussed are only a very few among the many uses that have already been found for computing equipment. They are not the most startling like the language translating computor, or applied to the most scientific purposes, like the equipment for controlling the Jodrell Bank radio telescope, but they stimulate the imagination in very well understood fields, where what are perhaps most understood are the limitations of the human senses, even when aided by instruments like micrometers and optical microscopes. Even the microscopic is macroscopic relative to the degree of division represented by the electronic scale of things, and with such distant limits the field for technological improvement and invention is obviously immense.

LOG SHEET

Power for Aluminium

About 70% of the aluminium metal used by the free world is produced in the United States and Canada due mainly to the relatively cheap hydro-electric power available for the smelting process and good transport facilities for handling the bulky raw materials. The many large rectifier stations built to supply power to these smelter furnace series, or pot lines as they are known, have hitherto been almost entirely American-designed water-cooled, pumped ignitron installations, and for this reason the new British electrical conversion plant at Baie Comeau in Canada is of particular interest. It is the first multi-anode pumpless air-cooled mercury arc rectifier equipment to be installed in the North American Continent for this application.

Against keen competition the British Thomson-Houston Company Limited were entrusted with the design, manufacture and erection of the converting plant for this important joint British-Canadian project initiated by the British Aluminium Company Limited. The order BTH obtained early in 1956 for two 100,000 amp 850 volt d.c. rectifier equipments for Baie Comeau was at that time the largest contract ever placed in the United Kingdom for mercury arc rectifier equipment.

As the aluminium smelting process is a continuous operation, requiring an uninterrupted supply of direct current over very long periods, the plant is designed to permit any item of equipment to be taken out of service for inspection, cleaning or maintenance without reducing the output power to any of the pot lines.

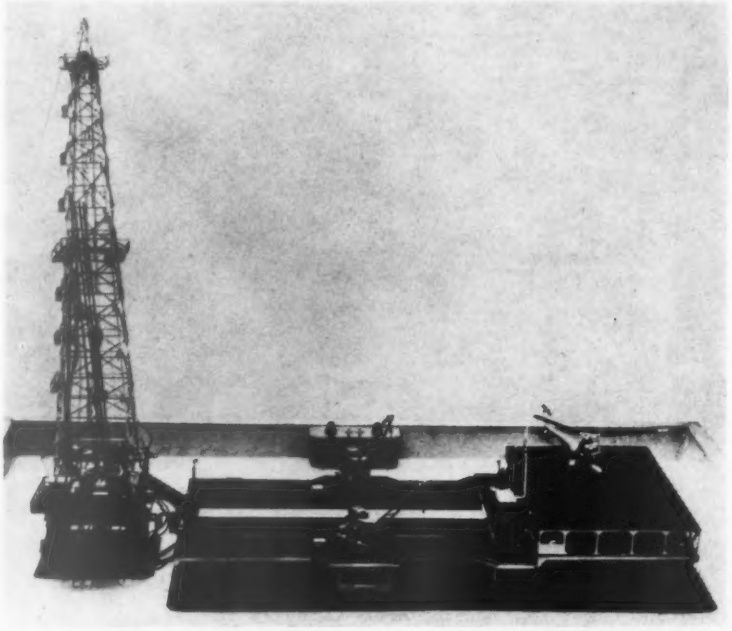
Power for the smelter plant is supplied from the Manicouagan Power Station over approximately 11 miles of two-circuit transmission line to the duplicate 161-kV site busbars. Each rectifier equipment feeding one pot line is then supplied through a step-down transformer and regulating transformer through the variable intermediate voltage busbars to which the rectifier transformers are connected. A duplicate standby intermediate voltage busbar system is supplied from separate standby step-down and regulating transformers. The rectifier plant supplied by BTH includes the 33-kV intermediate voltage switchgear as well as the power factor correction installation and the oil handling equipment for the site.

Each rectifier equipment supplying direct current to one pot line comprises eight units, each rated at 12,150 kW 14,300 amp which enables the full load requirement of 100,000 amp d.c. at 850 volts to be supplied on any seven units, i.e., with one unit out of service.

Small adjustment of d.c. voltage between tappings on the regulating transformer and reduction to zero voltage for short periods, which is occasionally required in the operation of the pot-line, is achieved by grid control of the rectifiers. The rectifier transformers for this installation are among the highest rated of their type in service. A separate phase shift transformer is mounted in each rectifier transformer tank to provide 48 phase operation of each rectifier equipment when all eight units are in service.

The 144 mercury arc rectifiers supplying each pot-line are of the standard BTH pumpless air-cooled steel tank design, mounted on withdrawable trucks and enclosed in folded sheet steel cubicles. Thus all equipment situated in the main rectifier room and operating at 850 volts is completely enclosed but ready access is provided for inspection and cleaning. This is a feature not generally provided in previous installations in North America, and in addition to the greater safety afforded to the operating personnel the arrangement undoubtedly improves the appearance of the station.

The severe icing and cold weather conditions which occur during winter months at Baie Comeau introduced additional problems in the design of the a.c. switchyard and the ventilating system of the rectifier building. Water cooling of equipment has been avoided and special measures have had to be taken in the design of the rectifier ventilating system to avoid large quantities of very cold air being drawn over the rectifier

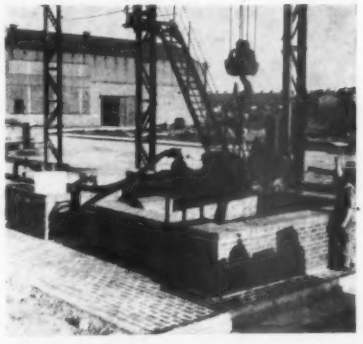


OIL SEARCH VESSEL.—Designed to help in the drilling for oil in the tidal mangrove swamps of the delta of the River Niger, an all-steel floating tender has reached Port Harcourt, Southern Nigeria, after being towed for over 4,000 miles by sea from Europe. The journey from the Netherlands, where the structure was built for the Shell-BP Petroleum Development Company of Nigeria, took six weeks. The tender, which includes a helicopter landing platform, will be the first to be used in a new phase of the expanding Nigerian oil search activities. A total capital outlay of £1,300,000 covers the cost of the tender's construction and of supplying its ancillary equipment. The picture shows a model of the floating tender with its drilling unit fixed on a platform placed on piles and driven into the sea bed

tanks. Some indication of the magnitude of this problem is illustrated by the fact that during the early construction stage of the project in January, 1957 the ice build-up on overhead conductors amounted to ½ in. and temperatures of minus 40° F were recorded.

Castings in Pickle

In order to provide facilities for the acid pickling of steel castings of wide variety and weight David Brown Industries Limited, Foundries Division, Penistone have designed and installed tanks capable of holding even the largest of their products. Employed in conjunction with hand fettling, pickling of castings in hydrochloric or sulphuric acid ensures that all foreign matter is removed from the metal, at the same time revealing defects, such as cracks, if these exist. It is anticipated that the largest of the Penistone company's castings to



A cast steel turbine case being lowered into one of two new acid pickling tanks which have been installed by David Brown Industries Limited, Foundries Division, at their Penistone works, near Sheffield

which the pickling process will need to be applied will be the half turbine casings, weighing up to eight tons, for which orders are currently on hand for conventional and atomic power stations.

Two identical tanks have been built, together with a neutralising sump. A two-way reversible pump serves both tanks and is capable of effecting complete transfer of the liquid in five minutes. After lowering the casting (or castings) into the empty tank, the slinging chains are removed, and acid is then transferred from the other tank.

By means of heating elements the acid solution (about 10% strength) is kept to a temperature of about 60° C at which heat pickling goes on for about two hours. By loading the second tank in the meantime a continuous flow of work is ensured. Only very infrequently is it necessary to dispose of the acid, this being effected after a neutralising lime solution has been added.

ENGINE TESTING.—All engine tests carried out by F. Perkins Limited, Peterborough, have now been centralized at the up-to-date Eastfield factory. This has been done in the interests of efficiency and enables reconditioned engines, currently totalling about 12,000 a year, to be tested at the main factory instead of in a separate shop at the Queen Street factory. Engines are fed into the test shop from the assembly lines by a King Dual-Duty overhead conveyor. A similar conveyor is used to handle engines despatched to the finishing department after testing. The main test shop at Eastfield is fitted with 80 test brakes. Twenty are Heenan and Froude dynamatic and ten Heenan and Froude hydraulic types, the remainder being F. Perkins Limited's design feeding back power into the mains and saving the company between £7,000 and £8,000 a year in electricity

Power in the Highlands

The stage reached in the development of the hydro-electric resources of the Scottish Highlands is shown by the following figures from the annual report of the North of Scotland Hydro-electric Board.

Hydro-electric schemes

729,326 kW capacity in operation with average output of 1,980 M units per annum.

147,650 kW capacity under construction with average annual output of 467 M units.

35,500 kW capacity promoted but not started with average annual output of 105 M units.

779,250 kW capacity in course of promotion and survey; average annual output 1,417 M units.

Power stations generated 1,913 million units of electricity during the year. The units produced by water power were 342 million more than 1956 and totalled 1624 million. This is equal to a saving in the year to the country of 875,000 tons of coal and on the basis of the cost of imported domestic coal as given in the Ministry of Power Annual Statistics for 1956, was worth £6,912,500.

The maximum demand on the board's mainland interconnected system measured at the generating stations was 411,000 kW in December. This does not include the islands and areas with independent generation for which about 21,000 kW should be added.

In 1957 the board exported 466 million units to the South of Scotland Electricity Board and bought 72 million units from the South at off peak hours. The arrangements for interchange of energy worked well throughout the year.

The total capital expenditure during the year amounted to £16,879,000 and the aggregate capital expenditure to the end of the year was £176,903,000 sub-divided as follows:

Hydro-electric schemes	£121,018,000
Steam and diesel power stations	5,559,000
Transmission lines	13,715,000
Distribution ...	35,085,000
Sundry	1,526,000
	£176,903,000

The number of contractors' men employed on the construction of hydro-electric schemes and on the erection of lines and the installation of equipment at the end of the year was 6100. The board's own employees numbered 2753.

Schemes with a total capacity of 779,250 kW and an estimated annual output of 1417·5 million units are under promotion or survey.

Handling Bulk Latex

In Malaya the plantations of the Dunlop Rubber Company Limited produce over 750,000 gal of latex per month. The raw latex, after being received at each estate factory, is prepared for shipment by treatment in centrifuges. These units, operating in a single stage, increase the rubber content of the latex from 35% to 60% rubber solids in the product for shipment, the reject material being coagulated to form low grade sheet rubber.

Although each tapper adds a few drops of ammonia when tapping, the centrifugal material requires further treatment and the latex is passed from the collecting tanks to ammonia treatment cells, usually by gravity but under compressed air when required. After treatment, the latex again falls by gravity or is pumped into road tankers for transport to the nearest rail head.

The individual estate requirements for compressed air is thus variable but the total number of compressors in operation on the estates and at the Singapore installation harbour totals 35 including 15 used for providing starting air for power house and pump station engines.

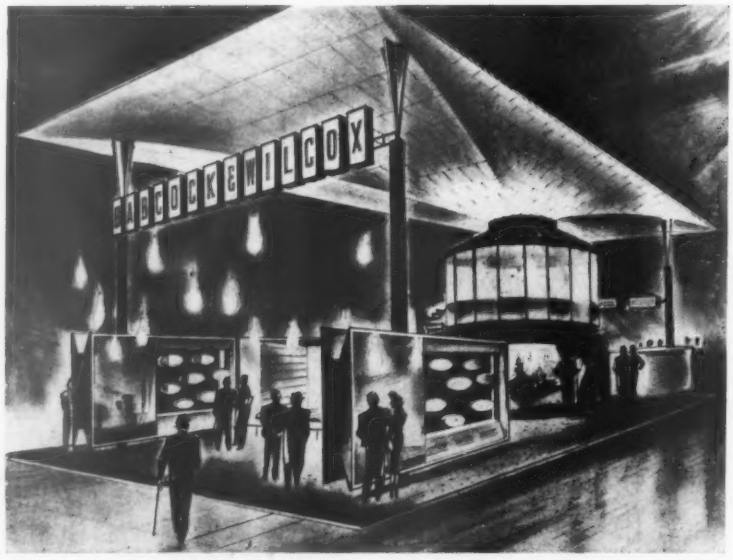
Transport from the rail head is in two sizes of tankers operated by the Malayan railways. The tankers are lined with bitumastic paint and the two sizes carry 3500 and 7000 gal respectively. The storage installation at Singapore consists of 50 horizontal cylindrical tanks each of 20,000 gal, the total capacity being over 1,000,000 gal. The storage tanks are connected to vacuum chambers which create the necessary vacuum to draw the bulk latex along the pipelines.

As the installation is located on a level site, large volumes of compressed air are required to push the latex through pipelines to the ship's tanks. Typical units employed are the Consolidated Pneumatic class TB10 × 9 horizontal single stage compressors. These are slow speed double acting water cooled compressors having Simplate valves of high delivery capacity, low air velocity and high overall efficiency. The cylinders have large well-rounded inlet and discharge passages which keep air resistance down and liberal water jackets in the cylinder heads and barrel extending round the valves give maximum cooling effect. The shaft is supported by Timken double row taper roller bearings, these being lubricated by a continuous oil flood.

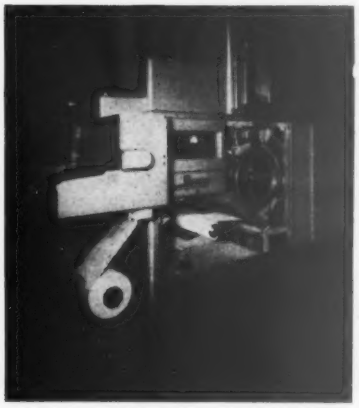
The pipe lines along which the latex travels are 6 in. internal diameter, except for the discharge into the reception tanks where the diameter is reduced to 4 in. The flow is controlled by valves, a large number of which are in use, mostly the Glenfield heavy duty 6 in. cast iron standard gate valve type produced by Glenfield & Kennedy Limited of Kilmarnock. Air manifolds are 3 in. bore steam pipe with 2 in. branches to each tank. Most of the air valves and three-way cocks are of local manufacture, but a number of Milliken valves are also in use.

Metal Prices

The fall in non-ferrous metals prices in the first half of last year was not unexpected but the downward slide in the second half of the year came as a shock. The annual review of The British Metal Corporation Limited attributes this to the poorer business outlook in the United States as the year went on. The years 1949, 1953 and 1957, when U.S. business activity swung downwards, were marked by low metal prices and the in-between high-price periods of 1951–1952 and 1955–1956 combined to produce a rhythm which suggests that markets may pick up about the middle of 1958, but this cannot by any means be taken for granted. The world as a whole is now more amply stocked with capital equipment and consumer goods which may mean that recovery will come more slowly.



POWER DISPLAYED.—At the Brussels Exhibition, Babcock & Wilcox Limited will present steam power as a major factor in the economic progress and well-being of mankind. Large paintings by Anna Zinkeisen and Claude Buckle, and colour enlargements and drawings depict conventional and nuclear installations. Half the space is devoted to the English Electric-Babcock & Wilcox-Taylor Woodrow Atomic Energy Group, with animated diagrams and a large animated model depicting the operation and constructional features of the nuclear power station at Hinkley Point, Great Britain, the largest in the world. The unusual stand structure was designed by Lucas Mellinger in collaboration with Felix Samuely and Partners, consulting engineers. The steelwork is by Edwin Danks & Company (Oldbury) Limited, of the Babcock organization, and the woodwork and display by Osters & Fleming Limited. The general display is by Beverley Pick Associates Limited in co-operation with the Babcock & Wilcox publicity department

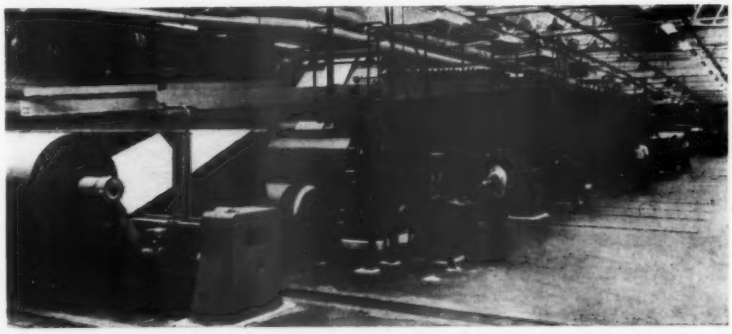


HIGH-SPEED PLAN COPYING.—The Copyflo continuous printer on which thousands of feet of microfilm received from the U.S.A., containing engineering drawings of guided missiles and related technical data, were enlarged automatically to translucent prints at the rate of one every three seconds. The machine, which is operated by Rank-Xerox Limited, 33 Mortimer Street, London W1, uses an electrical process which produces dry positive prints from a roll of plain paper without negatives or sensitizing. Printed, ink or pencil originals are copied as readily

Paper Corrugating Machine

The Langston-Masson corrugating machine recently installed at Reed Corrugated Cases Limited factory at New Hythe is one of the most modern anywhere in the world. The corrugator is an 85 in. unit designed mechanically for operating speeds up to 650 fpm and is driven by a multi-motor drive with Ward Leonard control supplied by Printing & Paper Drives Limited.

The machine has high speed heavy duty single facers both "A" and "B" flute, designed for operating speeds up to 650 fpm. Hydraulic loading of both the corrugating rolls and the pressure rolls enables the operators instantly and accurately to adjust pressures merely by watching a dial gauge in order to suit the particular grades of paper being run on the machine.



The new Langston-Masson 85 in. corrugating board unit in operation at the New Hythe, Kent, factory of Reed Corrugated Cases Limited (part of the Reed Paper Group). The machine, which is nearly 300 ft long, incorporates several new technical improvements and is built to operate up to speeds of 650 ft per min.

The adhesive mechanism is of the latest type and allows a very much closer and more accurate setting on the adhesive applicator roll which is designed to produce and extract the highest quality of board from the paper available.

Shaftless mill roll stands carry the 60 in. dia reels. By virtue of their design it is also possible to run split webs with reels having a minimum face width of only 18 in. All operations for handling reels on these stands are power operated with push-button control, completely eliminating the heavy manhandling normally involved.

Each single facer is provided with independent preheater and pre-conditioner units.

The tapered speed control drive on the gluing mechanism of the double glue machine is compensated automatically as the machine speed changes, eliminating warpage and reducing adhesive consumption and permitting a higher potential running speed of the corrugating machine. The glue machine is also fitted with electric automatic thrustors which raise the paper and table from the applicator roll when the machine is stopped.

The double facer which has 44 ft of heating surface and 44 ft of cooling, tempering and traction surface, incorporates the continuous running double facer feature or automatic order changing device as it sometimes known. This includes a rotary shear and automatically carries out order changes, without stopping the machine, in about 25 sec. Having preset the next sheet length on the cut-offs and the next station on the triplex slitting and scoring units, the whole operation is simply carried out by pressing a single control button, resulting in the following cycle of operations.

The speed of the double facer is automatically reduced to 200 fpm—the rotary shear severs the board—the double facer and glue machine then drop to a speed of 30 fpm while the slitting and scoring units and cut-offs continue at 200 fpm—at the same instant the severed web clears the slitting and scoring units, the preselected stations are automatically rotated into position under power control before the slowly advancing web has reached them—the cut-offs adjust themselves to their new pre-selected sheet lengths—the double facer and glue machine then return to 200 fpm completing the automatic cycle. The operator may then accelerate the machine manually to whatever higher speed was being run before the cycle was begun.

Each single facer is driven by a 50 hp motor whilst a 125 hp motor drives the double facer, the two triplex slitting and scoring units and the duplex cut-off.

Aerosols for Industrial Products

In addition to the many domestic uses for Aerosol containers there are now several industrial applications. One of these is for spraying silicone-based mould release agents, another for spraying flaw detection inks, and another is for aiding the starting of diesel engines in cold weather. A wide range of containers is now available manufactured from such differing materials as plastics, glass and metal. The first Aerosol containers to be marketed in Britain were aluminium impact extrusions fitted with a tinplate end which held the valve. Cans of 20-, 12-, six- and four-ounce nominal capacity are available and smaller sizes of one ounce or less may soon be introduced.

Tinplate containers are available in four-, six-, 12- and 16-ounce containers, and are favoured in view of their resistance to corrosion. Recently, experiments have been carried out to produce a stronger side-seam and this will serve to increase the safety of the containers, particularly those intended for export. Another recent development has been the use of glass for Aerosol containers. This material has obvious advantages, particularly from the aspect of corrosion. Successful research has been carried out on the problem of protecting the glass against breakage.

Extensive research has been carried out in connection with blow-moulded nylon bottles, and high-density polythene has also been investigated. The advantages of plastics containers include their resistance to breakage and their chemical inertness.

A wide range of Aerosol pressures can be obtained by utilizing various propellant mixtures. Normal internal pressure at room temperature is between 35–45 psi gauge. In the case case of glass bottles, pressures are not usually above 25 psi gauge.

The choice of propellant is governed both by the pressure required and by its chemical stability. The propellants in general use are liquefied gases, and their use has an important advantage. Pressure inside the container depends primarily on the vapour pressure of the propellant and not on the quantity which is present. Pressure remains constant as long as any liquid propellant remains in the container.

Scrap Baling Press

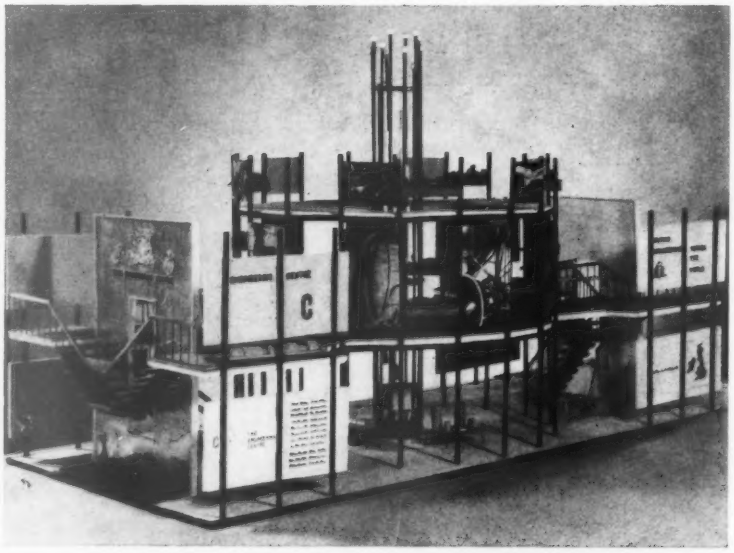
A new triple-compression hydraulic press, designed and built for Colvilles Limited by Fielding & Platt Limited, Gloucester, for the baling of heavy grade scrap metal, is completely self-contained and incorporates its own high pressure pump system, supply tank, control valves and hydraulically operated hopper, and can handle up to approximately 20 tons of scrap per hour.

The scrap for baling is compressed in three stages, the initial compression being applied over the whole of the baler box area by a massive hinged cover applying a load of 270 tons. Secondary compression, of 360 tons, is brought about by three rams moving a thrust face along the box axis inside the closed box. Final compression is by a single ram operating at right angles to the secondary and applying a load of 480 tons.

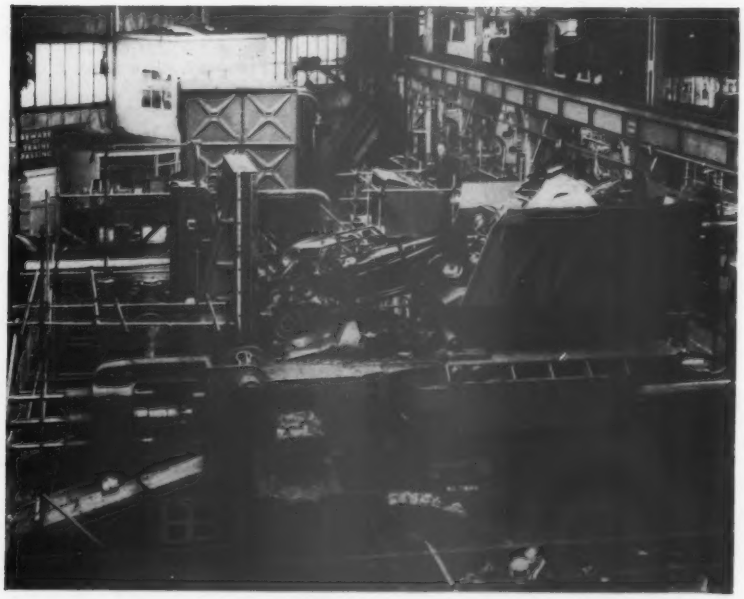
On completion of the operation the ejection door is opened and the final pressing ram ejects the bale on to the pusher gear outside the baler box. Steel cutting jaws are fitted to the baler box door to shear through overhanging scrap. The hydraulic medium (oil) is supplied by a battery of Fielding type H.3. totally enclosed reciprocating pumps at a maximum working pressure of 3000 psi.

All movements are controlled from a console desk by a handwheel selector. Indicator lamps and pressure gauges on the panel keep the operator fully informed of the motions of the press. Control valves are of the mitre seat, thrustor-operated type and by-pass valves fitted in the hydraulic circuit allow the pump motors to commence operating under no-load conditions.

Electrical interlocks prevent the hopper being operated until all the pressing rams are returned and the box is open, ensure that the secondary pressing rams have completed their stroke before final pressing commences, and prevent the ejection door being closed before the final pressing ram has been withdrawn.



A model of the Birmingham Engineering Centre's stand in the British Industry Pavilion at the Brussels Exhibition on which 85 firms from the light and medium engineering industries will display their products



The new Fielding triple compression hydraulic press, designed and built for Colvilles Limited by Fielding & Platt Limited, of Gloucester, for the baling of heavy grade scrap metal. The new press, which can handle up to approximately 20 tons of scrap per hour, is shown here in the course of loading; the scrap for baling including a complete car body

British Engineering at Brussels

The Universal and International Exhibition opening at Brussels on April 17 is the first world Exhibition in Europe since the war. British industries will be represented in the British Industry Pavilion, organized by the Federation of British Industries through its subsidiary, British Overseas Fairs Limited. This Pavilion shares a five-acre site—one of the largest in the Exhibition—with the British Government Pavilion.

The engineering exhibits will give a good impression both of the diversity of British engineering and of the export potentialities of an industry which, taken as a whole, now accounts for almost 40% of all British exports as compared with about one quarter of the total before the war. (During 1957 engineering exports totalled about £1,280 millions.)

The products of some 85 firms will be displayed on the stand of the

Engineering Centre, Birmingham. The stand, which will occupy a prominent position in the pavilion, is the work of Mr. Leslie Gooday, A.R.I.B.A., M.S.I.A. It is a two-storied welded steel structure with oregon pine floors, without solid walls and many of the exhibits will be suspended. Open staircases at each end give maximum accessibility and the end panels are sheathed in natural aluminium.

550 MW Reheat Boiler Unit

The 550 MW power station boiler designed by International Combustion Limited for the Central Electricity Generating Board's Thorpe March Power Station will, as far as is known, have a capacity greater than any single unit in the world.

Designed to serve the requirements of a corresponding 550 MW turbo-alternator, which is also very much larger than any now in operation, the single unit will have an output greater than any of the C.E.G.B.'s existing power stations. It will be greater than the whole of the output from the Battersea power station, London, and only at Barking, Essex and Hams Hall, Birmingham, where in each case there are three individual stations, is there a larger aggregate capacity of generating plant on one site.

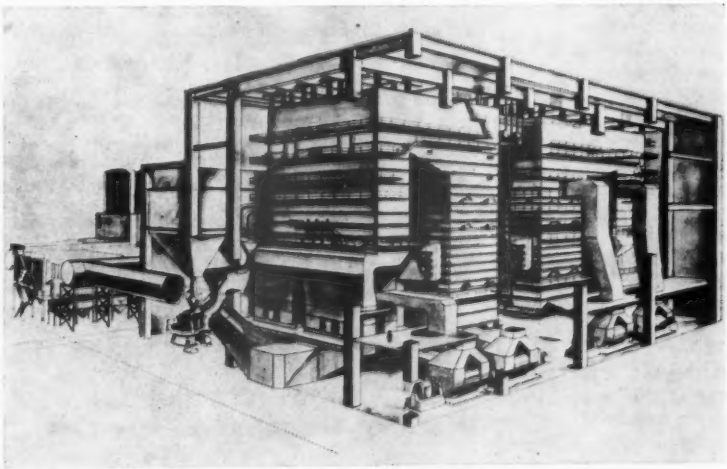
The decision to build unit plants of this large capacity is the latest step in the progressive development programme of the C.E.G.B., aimed at effecting economies in the cost of electrical generation by increasing the capacity and efficiency of the boilers and turbo-alternators.

By comparison with a 60 MW boiler unit, which was the largest being installed ten years ago in Great Britain, the new 550 MW unit will occupy about half the space that would be necessary for a series of 60 MW units with a comparable aggregate capacity. Further, by incorporating the latest design features, including assisted circulation, improved combustion chamber design, and increased capacity pulverizers, the capital cost will be about 65% of that which would have been involved with smaller units of only ten years ago.

About 2½ million tons of coal annually will be required ultimately for this power station, and because of this large consumption, the coal will be drawn from a wide area covering the Yorkshire coalfield and the northern parts of the Nottinghamshire coalfield. The quality of the coal will vary over a wide range, with ash contents from 6% to 30% and moistures from 4% to 20%. It will be small coal, of a type not generally burned satisfactorily by industry and quite unsuitable for domestic use.

Despite this wide range of fuels, which include some of the most difficult in the country in respect of propensity to choke the boiler with deposits, a thermal efficiency of 90% is guaranteed.

The design of this boiler unit is the logical result of years of continuous research and development, both by International Combustion Limited and the Central Electricity Generating Board and the far-sighted policies of both the Board and industry.



Drawing of the 550 MW reheat boiler unit which is to be erected at the C.E.G.B. Thorpe March Power Station

Operating conditions

Evaporation	3,750,000 lb/hr
Steam pressure	2,400 psi
Steam temperature	1,055° F
Reheat steam temperature	1,055° F
Feed pressure	2,600 psi
Feed temperature	496° F

Furnace.—Two per boiler. 68 ft wide × 28 ft deep × 100 ft high, each subdivided. One arranged for superheat steam temperature control and one for reheat steam temperature control.

Firing.—Pulverized fuel corner tilting burners.

Mills.—Eight per boiler (six to carry full load) each with normal capacity of 50 tons per hour.

Circulation.—Controlled and assisted by glandless pumps.

Heat reclaiming plant and draught equipment.—There will be two economizers, four air heaters, four forced draught fans and four induced draught fans.

Dust collecting plant.—Mechanical and electrostatic.

Sprayed Asbestos

The elimination of condensation, the provision of thermal insulation and fire resistance, the exclusion of dust and the correction of acoustical effects are all being effectively tackled by the Limpet asbestos spraying process which Turners Asbestos Cement Company Limited, Trafford Park, Manchester, are carrying out on a contract basis throughout the United Kingdom. By using the process on a single skin roof, fuel savings of 50% have been achieved and summer working conditions much improved by excluding solar heat. Condensation is prevented by maintaining the surface at about dew point: the asbestos absorbs many times its weight of water and this evaporated later when average conditions are established. A particular advantage is the prevention of condensation on exposed steelwork, thereby greatly reducing corrosion.

The asbestos fibres are specially treated and projected simultaneously with a fine water spray from a multi-jet spray gun. Various grades of asbestos fibres are used in order to meet certain essential functions. The resultant mixture is pliable for two hours, during which time the surface can be flattened or shaped. It becomes set in about eight hours.

Design of Belt and Rope Drives

After an outline of basic principles and properties of belts, the effects of initial tension, running speed and coefficient of friction on power transmitted are thoroughly discussed. The phenomena of creep and catenary effects are illustrated by numerical examples, and minor running losses due to bending and windage are estimated.

By G. H. RYDER, M.A.(Cantab.), A.M.I.Mech.E.

General considerations

AS a means of providing a drive between two shafts, belt or rope drives are comparatively cheap in first cost and in maintenance. The shafts need not be parallel and a wide range of centre distance is available. Their main disadvantage is that the velocity ratio transmitted is indeterminate due to creep under working loads with the possibility of slip if the limiting load is exceeded. This latter does, however, provide a convenient form of overload safeguard which may be valuable in certain types of drive. By suitable choice of materials, belts may be made to withstand extreme atmospheric conditions of heat and humidity or to work in the presence of dust or oil. The main advantage of the V-belt over the flat is the increased tension ratio obtainable without slip due to the wedging action; the same effect is obtained with ropes running in grooved pulleys.

Choice of materials

A brief summary of the types of belt and rope available and their relevant properties is given in Table I. The values should only be treated as approximate and will vary with the method of manufacture.

Leather may be had in laminations, the thickness of a single layer being $\frac{3}{16}$ to $\frac{1}{4}$ in. Woven belting is made in thicknesses from $\frac{1}{4}$ in. upwards. Woven hair or Balata belting is recommended when conditions of heat and humidity are involved. Rubber belting will give a long life in service provided there is no contamination by oil or grease. Steel belts can be run at very high speeds and have virtually no stretch, initial tensioning is critical, but its high strength enables considerable power to be transmitted for a minimum expenditure in belt and pulley materials.

V-belts and ropes are run in grooved pulleys, the included angle of the groove being normally 40° for V-belts and 45° for cotton ropes. Wire ropes are used for long distance haulage drives and are designed to run at the bottom of the pulley grooves.

Flat belts

If a belt has an arc of contact of θ radians round a pulley, the maximum ratio of the tensions (under *static* conditions) at its ends is given by the well-known relation

$$T_1/T_2 = e^{\mu\theta} = k \text{ say} \quad . \quad . \quad . \quad . \quad . \quad (1)$$

where μ is the coefficient of friction.

The *effective tension*, or tension difference

$$T_1 - T_2 = T_1(1 - 1/k) \quad . \quad . \quad . \quad . \quad . \quad (2)$$

and this determines the torque (and hence the power) which can be transmitted. The *Coefficient of Performance* is defined as

$$(T_1 - T_2)/T_2 = (k-1)/k \quad . \quad . \quad . \quad . \quad (3)$$

and represents the proportion of the maximum tension which can effectively be used. Fig. 1 shows how the coefficient of performance varies with arc of contact and coefficient of friction. In a drive between two unequal pulleys the coefficient of performance is of course determined by the smaller of the two arcs of contact, and it may be desirable in short centre drives to increase this by the use of an idler pulley.

When the belt is running at a linear speed v ft/min there is a centrifugal tension, due to curvature round the pulleys, given by

$$T_c = wv^2/3600g \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

where w lb/ft is the weight of the belt. The total tensions on the "tight" and "slack" sides are then given by

$$T_t = T_1 + T_c \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

and

$$T_s = T_2 + T_c \quad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$

If the *initial* (i.e. static, no load) *tension* is T_0 and the belt is assumed to have a linear elasticity and constant length under running and static conditions,

$$T_t + T_s = 2T_0 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (7)$$

This must be modified to allow for non-linear elasticity and catenary effects (see later).

From (1), (5), (6) and (7) it can be shown that

$$T_t = \frac{2k}{k+1}T_0 - \frac{k-1}{k+1}T_c \quad . \quad . \quad . \quad . \quad (8)$$

and that

$$T_1 = 2k(T_0 - T_c)/(k+1) \quad . \quad . \quad . \quad . \quad . \quad (9)$$

Table I.—BELT AND ROPE MATERIALS AND PROPERTIES

Type	Material	Coefficient of Friction (on cast iron pulleys)	Density lb/in.³	Modulus of Elasticity (cord value) lb/in.²	Working Strength (max. tension) lb/in.²
Flat belt	Leather	0·25/0·35	0·035	20,000	300/500
	Woven cotton	0·2/0·3	0·035	40,000	300/400
	Woven hair	0·2/0·3	0·035	30,000	300/400
	Balata	0·3/0·4	0·04	50,000	400/500
	Rubber	0·2/0·3	0·045	30,000	400/500
	Steel	0·15/0·25	0·28	30×10^6	10,000
V-belt	Fabric set in rubber	0·25/0·35	0·04	35,000	400
Cotton ropes	Stranded cotton	0·2/0·3	0·28d^2 lb/ft d in. = dia.	variable	200
Wire ropes	Stranded steel wire	0·15/0·25	1·5d^2 lb/ft d in. = dia.	variable	4000

The effective tension, equation (2), is then

$$T_1 - T_2 = \frac{2(k-1)}{(k+1)}(T_0 - T_c) \quad . \quad . \quad . \quad . \quad (10)$$

The horse-power which can be transmitted

$$P = (T_1 - T_2)v/33{,}000$$

$$= \frac{2(k-1)}{(k+1)} \frac{(T_0 - T_c)v}{33{,}000} \quad . \quad . \quad . \quad . \quad . \quad (11)$$

For a given drive this varies with speed after the manner of Fig. 2, and by substitution of T_c from (4) and differentiating, it can be shown that the power reaches a maximum when

$$v = 60\sqrt{(T_0 g/3w)} \quad . \quad . \quad . \quad . \quad . \quad (12)$$

at which speed $T_c = \frac{1}{3}T_0$ . . . . . (13)

and maximum power

$$\frac{4(k-1)T_0 v}{3(k+1)33{,}000} \quad . \quad . \quad . \quad . \quad . \quad (14)$$

Fig. 3 shows how the best speed of running varies with initial tension and weight of belt. For a belt run at its maximum working strength this speed usually falls in the region of 4000 to 6000 ft/min.

V-belts and cotton ropes

Due to the wedging action in the pulley grooves, the equivalent coefficient of friction for forces in the plane of the pulley and belt is

$$\mu_e = \mu/\sin\alpha \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (15)$$

where α is the semi-groove angle. The previous equations then apply, with

$$k = e^{\mu\theta/\sin\alpha} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (16)$$

It will be seen from Fig. 1 that the coefficient of performance can now be increased to over 90%.

Example 1. *A single V-belt of included angle* 40° *and weighing* 0.3 *lb/ft is to transmit* 20 *hp between two pulleys of* 1 *ft and* 3 *ft dia whose centres are* 4 *ft apart. If the coefficient of friction is* 0.3 *and the belt speed is* 5000 *ft/min calculate the value of initial tension and maximum running tension.*

From (15), $\mu_e = 0.3/\sin 20° = 0.878$

The arc of contact on the smaller pulley is

$\theta = 180° - 2\sin^{-1}(1/4) = 151°$

From (1) $k = e^{0.878 \times 151\pi/180} = e^{2.31}$

$= 10$

From (4) $T_c = \dfrac{0.3 \times 5000^2}{3600 \times 32.2} = 65$ lb

From (11) $20 = (2 \times 9/11)(T_0 - 65) \times 5000/33{,}000$

giving $T_0 = 65 + 81 = 146$ lb

From (8) $T_t = (2 \times 10/11) \times 146 - (9 \times 65/11)$

$= 213$ lb

Strength limitation to effective tension

Equation (11) gives the maximum power which can be transmitted at a speed v under an initial tension T_0, assuming limiting friction conditions, but the strength of the belt may be exceeded before these conditions are reached. The maximum running tension is T_t, and from (5) and (6), the effective tension

$$T_1 - T_2 = T_t - T_s$$

$$= 2(T_t - T_0) \text{ from (7)} \quad . \quad . \quad . \quad (17)$$

Fig. 4 shows how the maximum effective tension varies with the initial tension. Lines O L and O M are the limits under slipping conditions, the former neglecting centrifugal tension and the latter assuming the belt speed satisfies equations (12) and (13). Line PQ is the boundary imposed by the strength of the belt, i.e. equation (17). In any particular drive only the region OLQ or OMQ (depending on the allowance for centrifugal tension) is operative.

Example 2. *A woven fabric belt* $\frac{1}{4}$ *in. thick weighs* 0.035 *lb/in*^{3} *and has a maximum working strength of* 400 *lb/in*^{2}. *If it is to drive between two pulleys for which the smaller arc of contact is* 150° *and the coefficient of friction* 0.25, *find the maximum horse-power per inch width and the corresponding speed and initial tension.*

If the initial tension varies ±10% *estimate the limiting powers at the same speed.*

$$k = e^{0.25 \times 150\pi/180} = e^{0.654} = 1.92$$

To find the value of T_0 at M in Fig. 4, equate effective tension as given by equations (10) and (13) to that from (17), i.e.

$$(4/3) \times (0.92/2.92) \times T_0 = 2 \times 400 \times \tfrac{1}{4} - 2T_0$$

from which $T_0 = 200/2.42 = 83$ lb

From (12) $v = 60\sqrt{\dfrac{83 \times 32.2 \times 4}{3 \times 0.035 \times 1 \times 12}}$

$= 5500$ ft/min.

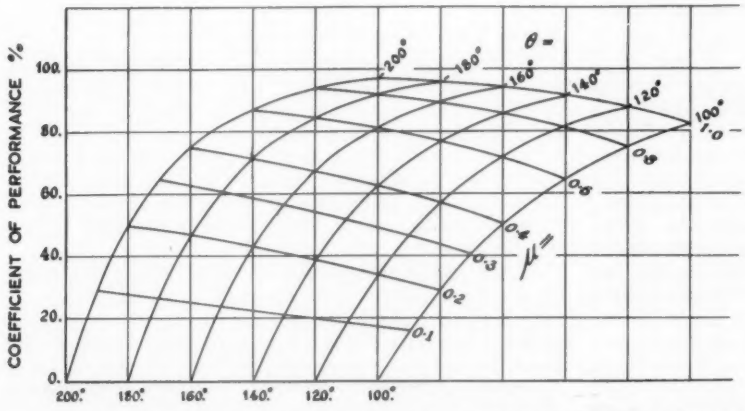


Fig. 1. Coefficient of performance against arc of contact and coefficient of friction.

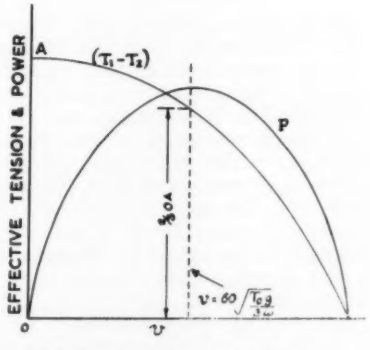


Fig. 2. (right) Variation of effective tension and power with belt speed

From (11) and (13)

Max. hp/inch $= (4/3)\times(0.92/2.92)\times(83\times5500/33{,}000)$
$= 5.8$

If T_0 is reduced 10%, the limiting line is OM (neglecting a slight variation in the ratio T_c/T_0), and the horse-power is reduced to 0.9×5.8, i.e. 5.2 approx.

If T_0 is increased by 10% the limiting line is MQ, with

$T_0 = 91.3$ lb.

Effective tension $= 2(T_t-T_0) = 2(100-91.3)$
$= 17.4$ lb.

H.p. at 5500 ft/min $= 17.4\times5500/33{,}000$
$= 2.9$

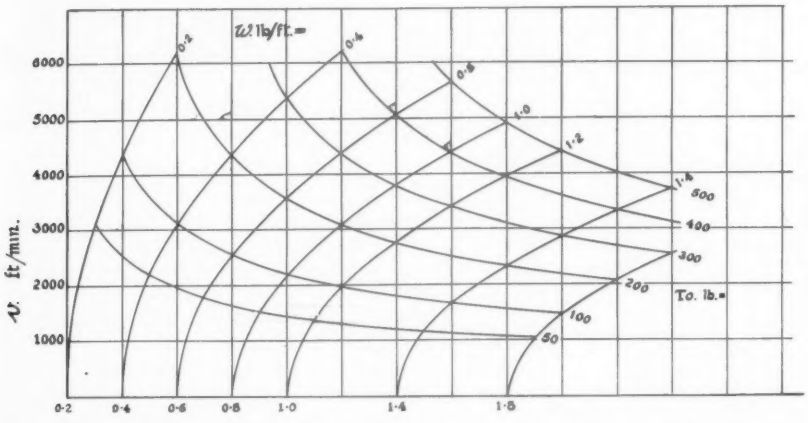
Note the danger of overloading the belt due to errors in initial tension, which should be set so that the running condition does not pass beyond the point M.

Effect of non-linear elasticity

Except for flat steel belts, all the materials used exhibit a stress/strain ratio which increases with the tension, and if the length of belt is to remain constant the sum of the running tensions must be greater than twice the static tension. i.e. equation (7) becomes

$$T_t+T_s > 2T_0$$

and there is a slight increase in the power which can be transmitted for a given initial tension (equation (11)).



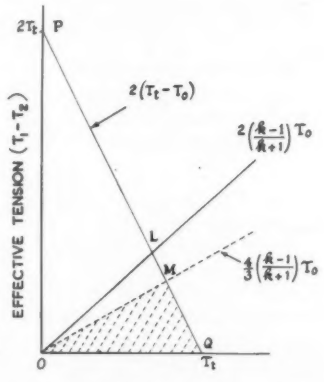


Fig. 3. Optimum belt speed against weight of belt and initial tension. Fig. 4. (right) Variation of effective tension with initial tension under slip and maximum tension conditions

Speed loss (creep and slip)

As the belt moves round the driving pulley from the tight side to the slack side the tension decreases and it therefore contracts in length. It has been shown experimentally that the belt and pulley speed are the same where the belt is coming on the pulley, and hence the slack side is moving at a lower speed than the driving pulley. Opposite conditions apply round the driven pulley, which has a peripheral speed equal to that of the slack side. The ratio of peripheral speeds of the two pulleys is therefore due to the difference in strains of the two sides of the belt, and the speed ratio can be shown to be

$$\frac{1+e_s}{1+e_t} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (17)$$

where e_t and e_s are the unit strains due to tensions T_t and T_s. Alternatively, the fractional loss of speed is

$$e_t-e_s \quad \text{approx.} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (18)$$

e.g. if $E = 30{,}000$ lb/in.^{2} (assumed constant), and the stresses on the tight and slack side are 400 lb/in.^{2} and 250 lb/in.^{2},

$e_t-e_s = (400-250)/30{,}000$
$= 0.5\%$ loss of speed due to creep.

In addition to creep there may be a bodily slip of the belt if limiting tension conditions are exceeded at any time.

Torque loss (bending and windage)

The loss in effective tension (and hence torque) due to the change in curvature of the belt as it passes on and off each pulley is due to hysteresis effects and increases with the ratio belt thickness/pulley diameter. This is the main reason why thin flat belts are to be preferred to V-belts on small pulley drives. If belt thickness exceeds 1/40 of the pulley diameter the permissible maximum stress must be reduced.

Windage loss is proportional to the square of the belt speed and the length of belt.

The total torque loss due to these effects will not normally exceed 2%.

Catenary effect (horizontal drive)

It is normal practice with horizontal and inclined drives to run with the "slack" side on top of the pulleys in order to increase the angle of lap. The free lengths of belt between the pulleys hang under their own weight in catenary curves, and this produces a tightening effect when running, the sum of the two tensions being greater than twice the static tension (compare equation (7)). This enables a greater power to be transmitted before slipping occurs.

If L is the centre distance between two equal pulleys of a horizontal drive, for a tension T the length of hanging belt exceeds the horizontal span by $w^2L^3/24T^2$ approx. Allowing for the stretch of the belt due to its elasticity (assuming a constant modulus E) and equating the change in length under static and running conditions due to elasticity and catenary effects,

$$\frac{L}{aE}(T_t+T_s-2T_o) = (w^2L^3/24)[1/T_t^2+1/T_s^2-2/T_o^2]$$

or $T_t+T_s-2T_o = (w^2L^2aE/24)[1/T_t^2+1/T_s^2-2/T_o^2]$ 19

where a is the cross-sectional area of the belt.

The tightening effect only becomes appreciable over long spans with a high tension ratio.

Example 3. *A horizontal belt drive spans two equal pulleys* 100 *ft apart. The belt weighs* 0.5 *lb/ft and has a cross-section of* 1.2 *in.*^{2}. *Its modulus of elasticity is* 50,000 *lb/in.*^{2} *and the maximum running tension is to be* 400 lb. *Find the initial tension required if* 20 *hp is to be transmitted* at 4000 *ft*/min *belt speed, and check that slipping will not occur if the coefficient of friction is* 0.3.

From the hp,

$T_t-T_s = 20\times33{,}000/4000 = 165$ lb.

$\therefore \quad T_s = 400-165 = 235$ lb.

Substituting in equation (19),

$400+235-2T_o = (0.5^2\times100^2\times1.2\times50{,}000/24)$
$[1/400^2+1/235^2-2/T_o^2]$

i.e. $635-2T_o = 152-12.5\times10^6/T_o^2$

By trial and error

$T_o = 308$ lb.

which compares with a mean running tension of 318 lb.

$$T_c = \frac{wv^2}{g} = \frac{0.5\times4000^2}{32.2\times60^2} = 69 \text{ lb.}$$

$\therefore \quad T_1 = T_t-T_c = 331$ lb.

and $\quad T_2 = T_s-T_c = 166$ lb.

$e^{\mu\theta} = e^{0.3\pi} = 2.57$

and since this is greater than T_1/T_2, slipping will not occur.

Weight of belt (vertical drive)

With a vertical drive there is a difference in tension between the top and bottom of the belt on each side of the pulleys equal to the weight of free hanging belt. This can be interpreted as a difference in initial tension between the two pulleys when using equation (7), and it is preferable to have the smaller pulley above the larger in order that the loss in tension at the lower pulley will be offset by a larger arc of contact.

Acceleration of belt

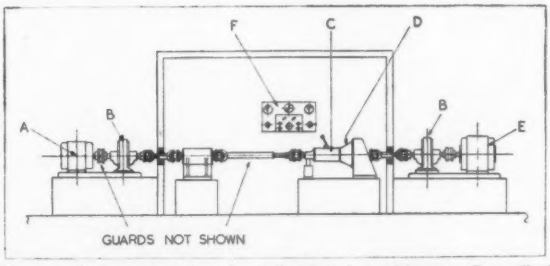
Under starting conditions, particularly in the case of loaded conveyor belts, a considerable torque may be required to accelerate the belt and its load.

Gearbox Testing Plant

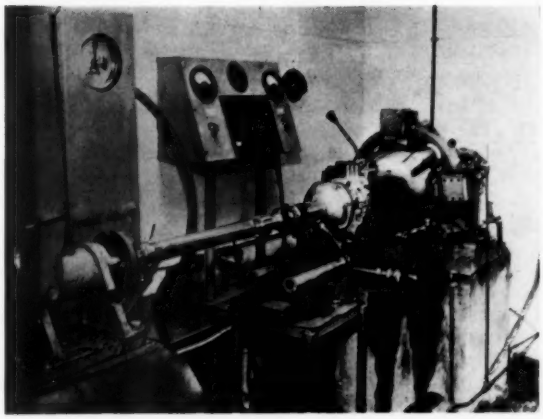
A PLANT for testing motor car gearboxes at varying speeds on all ratios, and to simulate actual road test conditions as closely as possible while permitting the operator to carry out his task speedily without the distractions which he would normally encounter on the roads, has been installed by Jaguar Cars Limited in consultation with Heenan & Froude Limited of Worcester, who designed and supplied the main equipment.

The gearbox for test, together with a slave clutch unit, is in a soundproof chamber and is driven by a variable-speed unit, its power output being absorbed by a further unit. Both units are mounted outside the chamber and are connected to the gearbox by shafts passing through the chamber walls. Provision is made for gearboxes to be tested under both "engine-driven" and "over-run" conditions.

All the controls are inside the chamber and are arranged so that the operator can adjust speeds and loads instantly and with the minimum effort. The gearbox under test is fixed in position by quick acting clamps and an air operated hoist inside the chamber enables the gearbox to be installed and removed quickly.

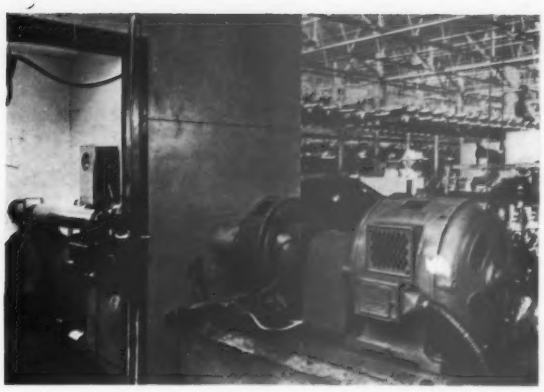


Diagrammatic arrangement of gear box testing plant. A, overdrive motor. B, coupling/brake. C, gearbox on test. D, slave clutch (foot operated). E, main drive motor. F, control panel



Interior of chamber with gear box in position

The driving unit is a constant-speed a.c. motor which, as it starts under no load, needs only the simplest of switch gear. The unit is connected to the gearbox from a Heenan-Dynamatic eddy-current coupling serving two purposes; in "engine-driving" tests it provides a variable speed drive to the gearbox and under "over-run" conditions it absorbs the power reaching it from the gearbox. A similar unit, identical with the first except for its motor which is of lower power, is coupled to the output shaft of the gearbox. Both units are controlled by Heenan-Dynamatic electronic equipment.



Main driving motor outside chamber. The overdrive motor is connected through the opposite wall

The normal test begins by the operator driving the gearbox at a low speed and applying load to the output shaft. The speed is automatically held constant, despite any changes in load, at any particular setting of the motoring control handwheel. The operator may vary the speed from a crawl to maximum, apply any load required and hold the speed as desired. For example, he can dwell as long as he considers necessary at any speed where he may suspect undue noise.

On completion of the test on one gear ratio, the operator turns a switch on his control panel from "run" to "over-run". This cuts out the speed-variation section of the Heenan-Dynamatic coupling of the main motor and brings into action the brake section of the coupling. The same switch creates the opposite effect in the coupling at the output side of the gearbox.

The output-side assembly is then used to test the gearbox by driving it from what is normally its output shaft and braking its input shaft, thus giving the same direction of torques and forces as when, in road conditions, the car is driving the engine, i.e., on the over-run. As before, the load and speed can be controlled as required.

As soon as the operator has checked the gearbox for run and over-run on this particular gear ratio, he changes into another ratio, and continues in this way until the gearbox has been tested in all gears. A foot-pedal, built into the rig and connected to the slave clutch, enables gear-changing to be carried out in the same way as on the road.

Both motors are run at full normal speed throughout the test, all speed variation at the gearbox being carried out by the Heenan-Dynamatic couplings.

The test plant has been in operation sufficiently long for a fair assessment of its value to be made. Jaguar Cars Limited have found it entirely successful, allowing the minimum loss of time in fitting and removing gearboxes, and in adjustment of speeds and loads, and proving convenient and reliable in operation. The high degree of silence prevailing in the test chamber has permitted sound and consistent judgment of gearbox noise.

Variable Speed Belt Drive Maintains Constant Tension

A motorized variable pulley drive with a non-elastic V-belt has been used for many years as a simple arrangement for obtaining a limited range of speed ratios between driving and driven member. The main disadvantage if fixed driving and driven centres are used is the loss of belt tension at the lower ratios, resulting in slip, undue wear on the belt, and loss of power.

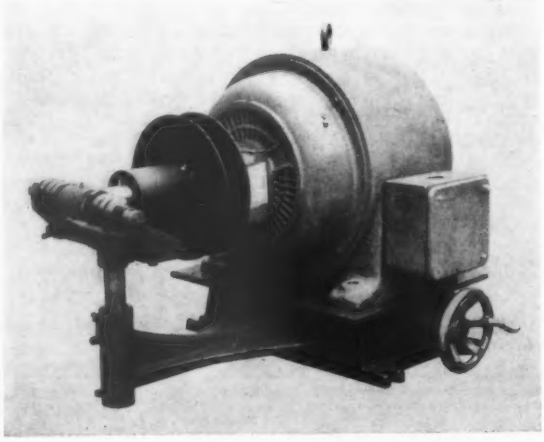
The Druce-Elliot variable speed unit with its new type of cam bar has been designed to overcome this problem and to maintain positive drive and maximum efficiency throughout a wide range of speed ratios.

The motor is mounted on a bed plate which, in turn, is mounted on guides in the base casting and set at a predetermined angle relative to the horizontal axis of the motor. A bracket bolted on the pulley side of the base is bushed to receive a vertical pillar upon which is mounted a T-plate or platform. This plate provides limited movement about the centre line of the vertical pillar for a bracket supporting a horizontal pillar, the centre line of which is adjustable to coincide with the motor axis, but to which it is offset. An extension of the pulley spindle is bushed to receive a sleeve along which it can slide in either direction and act as an additional thrust support. The sliding pulley flange rotates on enclosed lubricated ball bearings.

Actuated by a handwheel in the motor support base, a screw moves the motor in its guides towards or away from the driven unit, taking the pulley assembly with it. The outer, or sliding, flange of the pulley moves at a divergent angle to the motor slide, causing it to open or close according to the direction of rotation of the handwheel. The combination of these movements maintains a constant tension and alignment of the belt, irrespective of the speed ratio selected.

The height of the horizontal pillar assembly is adjustable to suit the size of motor employed; the offset angle can be set by micrometer adjustment to give the most desirable rate of opening or closing of the pulley in relation to the number of turns of the handwheel, and to compensate for belt wear. The sliding contact area of the horizontal pillar is gaitered for protection and to retain lubricant.

The Druce-Elliot variable speed unit, is at present manufactured in sizes to accommodate motors from ¼ up to 15 hp by Industrial Drives Limited, 44 Uxbridge Road, Ealing, London W5.



Druce-Elliot variable speed unit for drives up to 15 hp

Titanium Alloys Research

Titanium is the subject of extensive research as an alloying element in metals designed for resistance to intense heat and stress. Some of this work is summarized and results briefly assessed. Matters of immediate importance in the application of the titanium alloys are indicated.

ONE of the most interesting groups of titanium alloys is the titanium chromium group containing approximately 7·5, 4·6 and 2·35% chromium. These are being employed in the construction of aircraft and one problem facing the user is the choice of heat-treatment for alloys of this type possessing high strength if correctly treated. A series of experiments has been carried out on the various alloys of this type, and a useful instrument in carrying out the work has been the electron microscope.

The omega phase?

The effect of the research has been the establishment of isothermal diagrams, or, as they are more commonly known, S-curves (time-temperature-transformation diagrams) for the three main titanium chromium alloys mentioned. It seems that a new phase, to which has been given the name 'omega phase', has been detected, but its precise structure has not yet been determined nor is its existence as yet accepted as proved. There is reason to believe that this phase has a degree of responsibility for the hardening observed in beta-phase titanium, and that it occasions brittleness encountered when alpha-beta or beta alloys of the kind dealt with are subjected to moderately elevated temperatures. Nevertheless, the omega phase is not solely responsible for embrittlement, but it is fairly clear that it will cause brittleness in 7% chromium-titanium alloys if these are quenched from the alpha-beta region and later aged at room temperatures.

Brittleness is also held to be caused by the omega phase whenever the alloy is given too great a hardness as a result of comparatively slow oil- or liquid-nitrogen-quenching from the alpha-beta field.

Case-hardening titanium alloys

Commercial titanium alloys are liable to gall when they come into moving contact with other metals, and this lowers their efficiency in a number of industrial uses. In consequence, metallurgists have devoted a good deal of attention to methods of giving these alloys a lower tendency to gall and a superior resistance to wear, by means of surface-hardening treatments. Various case-hardening processes have been tried, including normal case-hardening with a carburizing compound, liquid carburizing in molten cyanide, and gas carburizing with various mixtures. It is not yet true to say that the work has been completed, but what has been sufficiently demonstrated is that surface-hardening does reduce the tendency to gall, and gives the alloys a good resistance to wear under loads up to 1300 psi. On the whole, gas carburizing with argon-propane mixtures seems to give the greatest resistance to wear.

Induction hardening

Induction hardening was also tried, but as far as galling is concerned, no improvement was observed, unless the alloys had previously been carburized by another process. Nevertheless, it would develop hard surfaces that could be of use under less severe conditions than obtained when parts are moving quickly under comparatively heavy load. The wear resistance of the induction-hardened alloys could not be determined.

As far as the research has gone, it can be said that it has shown the surface-hardening of titanium to be possible, but the ductility of the hardened case must be improved while at the same time a good measure of ductility in the core structure must be maintained. The cases so far obtained are too thin for effective use, because of the difficulty of machining, but experiments to overcome this are already in operation. Thin cases have, however, proved adequate in wear resistance, do not readily flake off, and resist limited impact and flexure tests.

Iron-vanadium-titanium alloys

Iron-vanadium-titanium alloys have been little studied, and in particular the effect of vanadium on such alloys is little known. Dilatation studies have therefore been carried out with a view to establishing the Ac_3 transformation temperatures of these alloys. The subject is highly technical and therefore the results are difficult to compress and expound in a short space, but it is now known that a little vanadium added to titanium and iron reduces the percentage of titanium necessary for the production of a closed gamma loop, but the influence of the initial 0·2% of either titanium added to iron and vanadium, or vanadium added to iron and titanium, is extremely small. The Ac_3 transformation, it should be explained, is the alpha to gamma transformation on heating, which, with the iron-vanadium-titanium alloys, is not isothermal. None of the alloys referred to in this connexion contains carbon.

Heat-treatment of titanium-molybdenum alloys

Titanium-molybdenum alloys and their heat-treatment have also been the subject of detailed study to determine the ability of the alloys to respond to heat-treatment; the mechanical properties produced by various heat-treatments; and the correlation of these properties and of microstructure with the heat-treatments. The alloys studied were those of 3, 7 and 11% molybdenum. Three basic conditions of heat-treatment were investigated, namely quenching directly from solution treatment temperature, water quenching, and quenching and reheating. In the first condition, the isothermally transformed alloys were quenched to the transformation temperature. All the heat-treatments were of more than five minutes duration.

The results obtained were of great interest. It was established that heat treatment of these alloys is capable of producing wide ranges of strength-ductility and impact strength, all of which properties are increased as the molybdenum content increases. The two higher molybdenum alloys derive the maximum benefit from quenching and reheating treatment. The mechanical properties have a definite relation to the time-temperature co-ordinated on S-curves or time-temperature-transformation charts. If the ductility of the alloys is high, it may be because of the presence of coarse precipitates of alpha evenly dispersed throughout the grain structure of the alloys. Lower ductility and impact strength appear to be associated with a fine irresolvable alpha of nodular appearance together with a precipitation of alpha along the boundaries of the grains.

Alloys that may have become brittle may be improved in ductility to a limited extent by long period annealing at temperature, or by choosing alternative time-temperature combinations.

Phase diagrams for titanium alloys

The next series of researches has been carried out primarily in military establishments, and consists of a study of titanium-nitrogen and titanium boron systems. The work done has been of highly technical type, involving the employment of metallography, X-ray diffraction and melting point data, all designed to produce suitable phase diagrams in the respective composition regions up to 17·5% nitrogen and 33% boron. The investigation has led to the identification of the structures of intermediate phases and the establishment of certain important values, while other data of some interest have also been obtained.

Nitriding the titanium alloys

Reference was made earlier to studies of the case-hardening of titanium alloys. In this connexion another interesting development must be mentioned, namely the nitriding of titanium with ammonia. This was investigated for precisely the same reasons, the tendency of these alloys to gall when used in applications involving wear, or when extruded or wire-drawn. Both nitrogen and ammonia nitriding were studied, and it was shown that there is no great difference between them, though nitrogen nitriding requires a longer time and higher temperatures to produce an almost identical result. The ammonia nitriding process is fundamentally governed by the temperature, the time and the composition of the gas used, but as the gas composition is dependent largely on the nitriding temperature, it is a variable of somewhat less consequence than time and temperature.

The thickness of the nitrided case was found to depend on the period of treatment, which, if it exceeded the critical, gave thinner cases. There is unquestionably a best treatment time for each temperature in regard to production of the greatest possible thickness of case. The time or temperature of treatment does not much influence actual surface hardness, and long treatment periods make the core harder without affecting the surface hardness.

The process is intricate and not all is known as yet about the way in which it acts.

Tensile strength and heat-treatment

High strength alloys with a base of titanium and containing such additional elements as chromium, manganese or molybdenum, have been found to be liable to age-harden, either as the result of cooling at a critical rate from a temperature in the alpha-beta or beta-phase regions, or by quenching from this temperature range to retain the beta phase, followed by reheating for a sufficient time at temperatures above approximately 90° C. It was decided to investigate the influence of different heat-treatments on the tensile strength and hardness of a number of experimental titanium alloys of high strength, and also the effect of hot rolling temperatures in the age-hardening regions of alpha-beta and beta-phase, as regards the properties manifested after a later heat treatment.

It was demonstrated that the influence of heating in these regions and of cooling at a comparatively quick rate differed with the composition of the alloys, the solution temperature, the rate of cooling and to a certain degree the temperature of rolling. The treatments developed tensile strengths in the region of 62 to 76 tons per sq in. in bar stock with good ductility at each strength produced. If the alloys were solution treated up to 370° C, age hardening usually resulted in high strength and low ductility. Overageing within the temperature range 420–600° C followed by solution treatment in the alpha-beta phase region gave excellent properties over a wide range of strength, tensile strengths being over 90 tons per sq in. with elongations of 10% in 1 in. or more. Overageing of the heats rolled in the beta-phase region developed low ductility in two out of the three alloys tested, and solution treatment in this region in advance of ageing caused brittleness in all.

Overageing also gave good stability at elevated temperatures, the properties of two out of three alloys heat-treated to approximately 90 tons per sq in. tensile being unaltered in essence after 1000 hr at 260° C. The third alloy heat-treated to an ultimate strength of about 95 tons per sq in. remained stable up to a minimum of 500 hr at 260° C. The alloys which were the subject of these experiments contained (i) from 3·65 to 4·51% chromium, and 4·13 to 3·22% vanadium; (ii) from 3·80 to 5·60% manganese and from 1·69 to 2·8% chromium; and (iii) from 1·05 to 1·39 chromium, 0·96 to 1·0% iron, 3·61 to 2·95% manganese, 1·05 to 0·90% molybdenum, and 1·0 to 0·93% vanadium.

Aluminium in titanium alloys

We must also mention another interesting investigation, covering the transformation kinetics and mechanical properties of alloys containing titanium, aluminium and molybdenum. The object of this was to develop the most satisfactory alloys in the shortest possible time and with the minimum total effort. Its actual scope was the influence of ternary alloying elements on the properties of the titanium-aluminium alloys.

Here again, the results are highly complicated, but a brief summary indicates that the alloys of this type containing above 4% of aluminium do not reveal any improvement in strength at moderate temperatures and are particularly lacking in ductility as compared to those alloys with a lower aluminium content. The response of the alloys to heat-treatment depends largely

on the amount of molybdenum present. Where this is of the order of about 2%, the alloy becomes very hard when quenched in water; for molybdenum contents between 2 and 6%, the alloys exhibit ability to be both quench-hardened and age-hardened. If the molybdenum content is above 6% up to about 10%, maximum hardness is attained only on ageing ot the super-saturated beta solid solution.

In the 6% molybdenum alloys, variation of the cooling rate from the beta solution treatment temperature produces marked variations in strength and ductility, and also in tensile strength.

Safer Mechanical Splicing

A method of mechanical splicing for standard six-stranded ropes which results in a performance at least as strong as a well made hand splice is being adopted by British Ropes Limited, Doncaster. For ease of handling during the formation of the splice the makers are using their Blue Strand preformed wire rope, a rope construction in which the wires are preformed into the helical position they take up in the finished rope, so that even after cutting, the ends of the rope remain in place and require no whipping. The Superloop as the method is called embodies a mild steel sleeve closed over the tails of a Flemish eye splice and though the present range covers rope diameters from $\frac{1}{16}$ to $1\frac{1}{2}$ in. it is intended to increase this to $2\frac{1}{2}$ in. dia (8 in. circumference).

To make a Flemish eye, which is the basis of the Superloop, three strands are un-laid and the remaining three strands and core bent back to form a loop. The first three strands are then re-laid back round the loop until the eye has been completed as shown in Fig. 1. The core tail is then cut out, fibre cores being removed with a knife and wire cores cut with a portable grinder and the six tails laid in the interstices of the main body of the rope.

A slim tapered sleeve previously passed down the wire before splicing is now fitted over the splice and tapped in position to entirely cover the tails. To complete the Superloop the sleeved splice is placed in a four-jaw segmental die Fig. 2, the jaws sliding in 45° V-blocks to close the sleeve. The press is designed to work at low pressure to avoid crushing the splice and damaging the main body of the rope. Any flashes resulting from pressing are removed by grinding or filing before proof loading, and afterwards the sleeves are stamped with the identification details, and the safe working load.

The practice at British Ropes Limited is to proof load a sling to twice its safe working load and depending on a safety factor 5 to 1 or 6 to 1, the test load will be either 40% or $33\frac{1}{3}$% of the nominal breaking load of the rope.

If extra protection for a sling eye is desirable a stirrup made from white heart malleable iron can be fitted prior to the proof loading stage. The neat appearance of the stirrup may be judged from the illustration. Replacement of stirrups in service is a simple operation and can be performed on the spot.

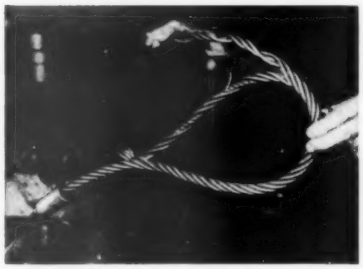


Fig. 1. Laying up the splice. The three strands are relaid back to form the loop of the Flemish eye

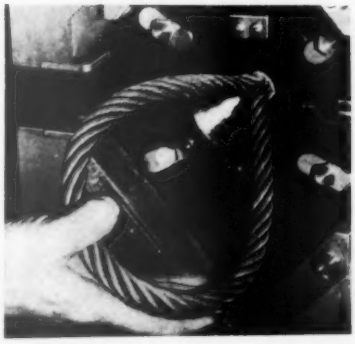


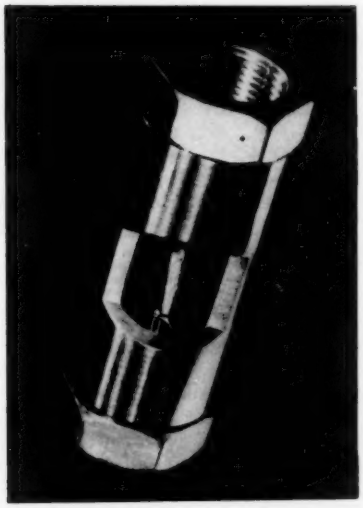
Fig. 2. Press closes the sleeve. Specially designed dies permit comparatively low pressures to be used, eliminating any serious damage due to crushing

Fig. 3. The finished Superloop fitted with stirrup to give additional protection while retaining the flexibility of a soft eye

Rotary Vane Flow Indicators

The Telicator visual flow indicator, a simple compact unit designed for high or low pressure systems, can be successfully used for extremely high or low rates of flow at any viscosity. Comparative flow can be readily assessed from the rate at which the rotor is revolving—this rotor being clearly visible through its cartridge case of perspex or glass. Complete reliability is afforded by the simplicity of the unit with its sprung jewelled bearings and strong metal external casing.

Telicator flow indicators are produced by Dukes and Briggs Engineering Company and distributed by Sir W. H. Bailey & Company, Albion Works, Patricroft, Manchester. Apart from the standard range for single- or multi-circuit indications a special model is available for use with opaque liquids.



The Telicator visual flow indicator. The rotor revolves in the transparent cartridge case of perspex or glass

Heat Recovery and Pollution Removal by Catalytic Combustion

The discharge to atmosphere of combustible products from many industrial processes is a major cause of atmospheric pollution and is often the source of considerable heat loss. These problems have been successfully dealt with for several years in U.S.A. by catalytic combustion and the method is now being developed on a commercial scale in this country

By A. R. MYHILL, F.R.I.C., M.Inst.Gas E., M.Inst.F.

THERE are many industrial processes in which inflammable gases or vapours are expelled from the plant in relatively small concentrations in accompaniment with a forced or induced atmosphere of air.

Examples of such processes may include:

(a) Paint and varnish manufacture, in which drying oils (linseed etc), gums, and resins are heated to high temperatures in open vessels.
(b) Drying of lithographed or painted metal sheets.
(c) Stove enamelling of iron and steel products.
(d) Foundry core baking.
(e) Firing of wax-bonded ceramic products.
(f) Enamelling of insulated copper wire.

Many other processes could be cited, but most of them are essentially those in which a manufactured product is coated with a decorative or protective layer applied as a solution or suspension of a solid in a solvent, the latter being a volatile organic chemical which vaporizes during the process, leaving a durable coating of the required nature. Drying is carried out in either static or conveyor ovens, by the combined agencies of heat and draught, the effluent vapour, which usually consists of hydrocarbons such as benzene or paraffin, ethers, alcohols,

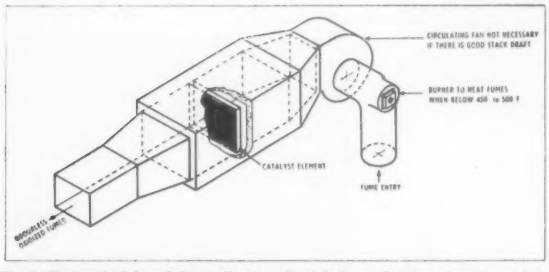

CIRCULATING FAN NOT NECESSARY IF THERE IS GOOD STACK DRAFT
BURNER TO HEAT FUMES WHEN BELOW 450 to 500 F
CATALYST ELEMENT
FUME ENTRY

Fig. 1. Basic principles of the application of catalytic combustion of waste products from ovens and furnaces. Exhaust may be: passed through heat exchanger to heat incoming fumes; recirculated to utilize heat generated; used in other processes; passed to atmosphere.

aldehydes and other organic substances of low boiling point, being ducted to waste in the air-stream.

In all these cases, the concentrations of inflammable vapour will be much below the lower limits of inflammability, so that, although there will, normally, always be much more oxygen present than is necessary for complete combustion, no combination with the vapour can take place unless special devices are introduced for the purpose.

In addition to the examples quoted above, which are all drying or baking operations, there are other processes where similar low-concentration effluents are discharged, e.g. in the case of fumes from internal combustion engines or from coke furnaces where carbon monoxide, hydrogen-sulphide, or/and oil vapours may be carried forward.

Where conditions of this nature prevail, there are certain factors which may assume importance. These are the pollution of the atmosphere and the waste of heat discharged as potential calorific value of the combustibles in the effluent gases.[2]

The problem has been successfully dealt with in the U.S.A. for several years, by catalytic combustion.

In cases of normal combustion by flame propagation, two essential conditions are necessary. These are a sufficiently high ignition temperature and a fuel/air ratio within the inflammability range. If the fuel/air ratio is too low, the flame is extinguished, and can only be maintained by the application of external heat to raise the temperature, which, in many practical instances may need to be between 1000°F and 2000°F. By passing the gases containing the fumes over a suitable oxidation catalyst, however, a local high temperature is developed by the oxidation of the unburnt gases or vapours, and

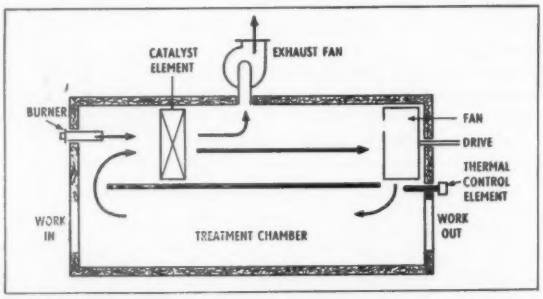


Fig. 2. Catalytic combustion of fumes from an enamelling oven, showing recirculation of hot products

all these substances are completely burnt to carbon dioxide and water vapour at an oxidation temperature which may be below 500°F, and the combustion has no minimum fuel/air limits. The greater the concentration of combustible material passing through the catalyst element, the higher will be the temperature developed, and the heat liberated per unit of combustible is the same as with flame combustion. With high concentrations the catalyst will glow, otherwise there will be no visible evidence of combustion.

Developments, based on American experience, are now in progress, with a considerable measure of success in this country.

In many cases the object is simple the deodorizing of waste-gas fumes to avoid fouling of the atmosphere in or near to buildings, but where large amounts of effluent gases are treated, the heat produced by oxidation can often be utilised in a re-circulation circuit for pre-heating the air passing through a drying oven or feeding a furnace or boiler grate.

Where pre-heat is given in this way to scavenging air, as in drying or enamelling, the products emerging from the catalyst element may be passed directly to the oven, and, since no combustible matter is present, fire or explosion hazards are absent. If the products are needed

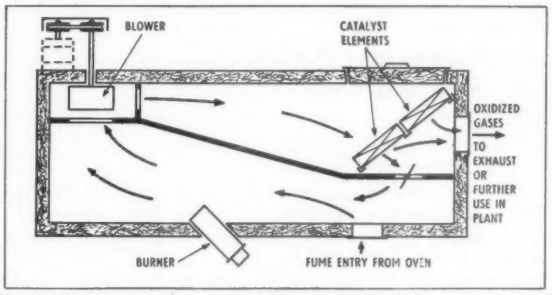


Fig. 3. Heat recovery from waste products containing high concentrations of contaminants

to pre-heat air for a furnace or gas producer, it may be necessary to use an air/products heat exchanger, which, of course will not have such a high thermal efficiency as is obtained by direct circulation, but will ensure freedom from excessive diluents such as CO_2 and nitrogen. It is therefore necessary to design the system in accordance with conditions and requirements. A practical example taken from American practice has been described by L. C. McCabe,[1] in which the vapours from the solvent used in a gas-fired process for enamelling metal strip are utilised for augmenting the fuel gas supplies to the furnace. The elimination of the vapours escaping from the process (consisting of toluene, xylene, and alcohols) simplifies the ventilation system of the factory.

The catalyst employed, usually consists of a base of platinum, or other metals of the platinum group in a particular state of fine division, bonded on to nickel alloy ribbons packed into a frame which extends completely across the fume duct. The general arrangement is shown in Fig. 1. Although the metals used for the catalyst are relatively costly, they are not lost to any appreciable extent in use, and the maintenance costs are very low when used under correct conditions, a re-activation service being provided by the makers. As an example, the catalyst life in the case described by McCabe was 4000–5000 working hours.

Two factors are important in preserving the life of the catalyst and maintaining the efficiency of the process. Many catalysts, especially those of the platinum type, are susceptible to "poisoning" by certain substances such as sulphur, and where this is present in the gases, a shorter life may be expected. Such poisoning is more likely to take place where fumes from coke, producer-gas or coal-gas appliances are being treated than when dealing with organic vapours from a drying or baking oven in which the products of combustion of the heating source are prevented from entering the drying chamber.

In special cases, trouble might be expected where oxides or other compounds of iron, lead or arsenic pass forward in volatile or mist form. Where large amounts of fly-ash or grit are present, they should be removed in a precipitator before passing the gases over the catalyst, in order to avoid partial blockage or coating of the active surfaces.

The catalyst temperature is also a matter of importance. The threshold temperature is about 500°F, so that, unless the effluent gases are above this temperature, a pre-heat burner is necessary to raise the temperature of the gases to this level. It is not always necessary to maintain this extra supply of heat, since the combustion of the substances present may supply sufficient heat, once ignition has been effected.

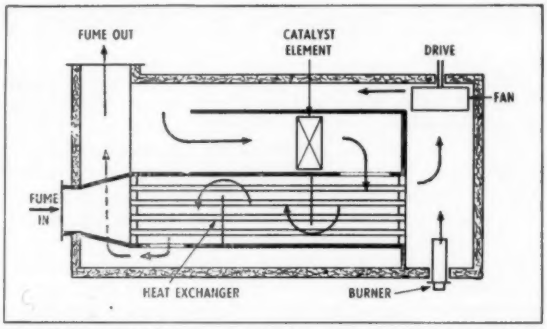


Fig. 4. Treatment of fumes containing low concentrations of combustibles.

Although combustion may be self-maintained, it is generally desirable to ensure that an optimum temperature is reached, and this is about 1200°F. In some cases, therefore, it may be necessary to add heat to the system, while in other cases it might be desirable to arrange for dilution with cool air or gas to prevent overheating.

If the concentration of combustible products, and their quantity are sufficient to warrant heat recovery, a fan is generally required, together with a pre-heating unit, which should be thermostatically controlled, and a return system for the hot clean gases to pre-heat the air for the furnace or process.

If the amounts and concentration of combustibles are not sufficiently high to allow of heat recovery, but it is desired merely to oxidise traces of contaminating material, it will be necessary to install a pre-heater in the form of a burner or heat exchanger to assist in heating the gases entering the catalyst chamber.

In this country, Messrs. W. C. Holmes and Company Limited, Huddersfield[2] have developed equipment for the catalytic treatment of fumes from furnaces, ovens etc., under the trade name of the "Catco" process. Catalyst elements of standardized dimensions are used, and can be grouped to handle any desired volume of fumes. The pressure drop across a complete assembly is low, being of the order of $\frac{1}{4}$ in. to $\frac{3}{8}$ in. water gauge.

Figs. 2, 3 and 4 illustrate applications of the Catco system under different conditions.

Fig. 2 shows an enamel baking furnace in which fumes are generated at temperatures above the minimum catalytic combustion temperature. The fumes are drawn through the catalyst element where the temperature becomes raised, due to combustion of the organic vapours. The heated gas stream then divides into two passages, one part being discharged to atmosphere, and the remainder circulated through the process equipment

and used to pre-heat the scavenging air used for the oven or furnace.

Fig. 3 shows a Catco plant working under conditions in which the temperature at the inlet to the catalyst is below the minimum catalytic temperature, but where the concentration of inflammable constituents is of the order of 20% of the concentration at the lower limit of flammability.

After heating the plant to the combustion temperature, fumes are admitted to the process and circulated by means of a fan through the unit. After catalytic combustion has taken place, part of the hot oxidized gases, sufficient to pre-heat the incoming fumes to the catalytic combustion temperature, is re-circulated round the Catco unit. The hot oxidized gases discharged from the plant can be utilised in the fume-making process, or can be passed through a waste-heat recovery system where the heat produced by catalytic oxidation of the fumes may be utilized.

Fig. 4 illustrates a method suitable for treating fumes which are below the catalytic combustion temperature, and where the concentration of inflammable constituents is so low that the re-circulation system shown in Fig. 3 cannot be employed. The fumes to be treated are first passed through the tubes of a heat exchanger around which flow the hot oxidised gases before being discharged to atmosphere. After this initial pre-heat, the fumes are heated to the combustion temperature, where necessary, by means of a gas or oil burner, before passage over the catalyst. By this means there is a considerable saving in fuel used to pre-heat the incoming fumes to combustion temperature, as compared with the simple system shown in Fig. 1.

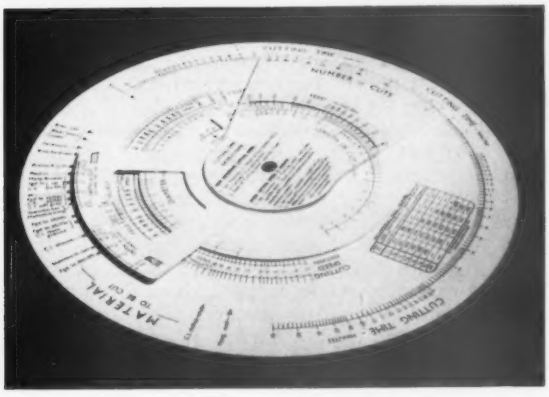
References:

1. L. C. McCabe, *Ind. Eng. Chem., 1953, 45, 109A.*
2. J. G. King, "The Holmes-Catco Process in Heat Recovery". *Gas Times, July 19, 1957.*

Machining Time Calculator for Ratefixers

Intended to be the first of a range of similar instruments for use by ratefixing and estimating departments, a circular slide-rule for calculating machining times has been announced by Fearns, Mear & Company, St. Helens Road, Almondbury, Huddersfield.

The use of the calculator it is claimed will enable machining times for turned components of all kinds, produced on centre-lathes, turret and capstan lathes and boring mills to be determined quickly and accurately. Actual times required (including all normal allowances), are read off directly after the simple setting of a few scales.



Circular slide rule for speed determination of machining times for lathework of all kinds

Cutting time may be read off on one side of the calculator after setting the dials to the appropriate information such as material, type of tool, diameter of work, length and number of cuts, etc. Other dials and scales on the reverse side of the calculator give the time increments for loading, manipulation, gauging, etc., taking into account the necessary allowances according to the type of work being undertaken. Setting up times are also provided in a separate section.

The instrument is suitable for any turned component between $\frac{1}{8}$ in. dia. and 80 in. dia., and lengths between $\frac{3}{16}$ and 200 in. It is made of transparent and white perspex, with four colour engraved scales and supplied complete in a cloth covered case.

Resistance Welder for Research

Research work into spot, seam, roll spot or projection welding can be conducted in the laboratory by the aid of a resistance welder, model UAM 150, a machine which has recently been produced by Sciaky Electric Welding Machines Limited, of Slough, Bucks.

To make the machine suitable for practically every kind of metal, the pressure head is pneumatically controlled and provision made for one, two or three pressure cycles. Fully electronic control permits extremely accurate timing control from $\frac{1}{2}$ cycle upwards, phase shift stepless heat control, slope control and preheat and/or post heat. Three fully synchronous basic Sciaky Dekatron timers plus motor control give an almost infinite combination of machine settings.

Heavy duty spot, projection, seam or roll spot welding may be done on the machine, the two lower arms are supported on pillars, one on each side of the machine and the seam or roll spot arm when clamped into position engages with a shaft from the infinitely variable speed motor/brake unit. To assist the seam welding of coated materials an extra tool is available to knurl the electrode faces. For spot welding, the T-slot platen equipped lower arm is used in conjunction with bolted on electrode holders and the arm not in use swung through approximately 180° to lie along the machine's main frame well clear of the operator.

The machine control circuit and time control equipment is housed in a separate cabinet to eliminate any inaccuracies due to vibration of the interaction from the welding transformer fringing fluxes.

Routing Cutters Under Test

High rates of metal removal are claimed for the new Clare routing cutter which has been designed to obtain high spiral, high rake and the largest possible percentage of chip area. For example, working under conditions of 'packing' in slot and cavities where chips are not readily cleared a $\frac{3}{4}$ in. dia 3 flute routing cutter machining En 9, will slot 1 in. deep at feed rates up to 10 in. per min. On a production run, cutting steel castings, a $2\frac{1}{2}$ in. dia router cut a slot $2\frac{1}{2}$ in. wide × $1\frac{1}{2}$ in. deep at 2 in. feed, obtaining a 7·5 cu in./min metal removal rate. The range made by Clare Collets Limited, Broadheath, Altrincham, Ches., covers $\frac{1}{16}$ in. dia—$2\frac{1}{2}$ in. dia with 3 flutes, and $2\frac{3}{4}$ in.—3 in. dia with 5 flutes. Cutters above 3 in. dia can be made for special requirements.

Electric H.S. Steel

While the mains frequency coreless induction furnace is well known in the production of ferrous and non-ferrous alloys, its use for making high speed steel has been hindered by the possibility of inclusions arising from the turbulence of the molten metal which is chracteristic of this type of furnace.

The Inca Steel Company Limited, Sheffield, have given a good deal of attention to the problem in conjunction with Birlec Limited and Otto Junker GMBH of Lammersdorf, Germany, and technical and operational methods have resulted which have been embodied in a new installation at the Sheffield company's works.

The Birlec furnace at Inca has a capacity of 1½ tons and a power input of 450 kW can be applied giving a maximum output of some ½ ton per hour of prime high speed steel ingots. Flexible power input control enables metal temperature to be closely adjusted.

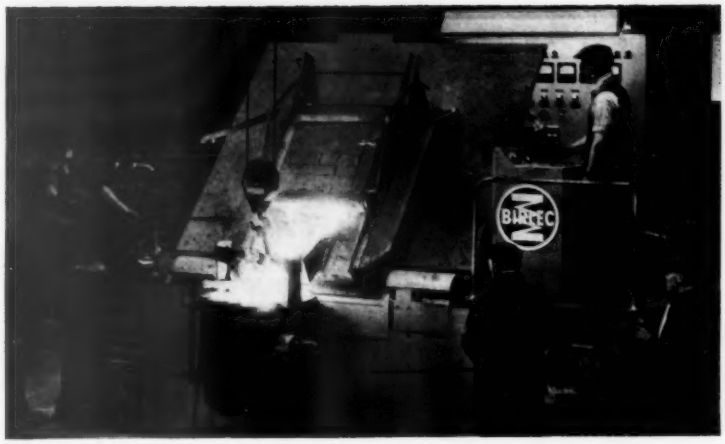
The furnace is charged with selected scrap, a heel of molten metal being retained from each heat as the basis for the following charge. Mounted flush with a working platform about 4 ft above the foundry floor, the furnace is tilted by hydraulic rams, served by a self-contained pressure unit. A bottom pouring ladle transfers the metal to the ingot moulds.

Teething troubles are reported to have now been overcome and prejudice regarding non-metallic inclusions proved baseless. The cleanliness of the steel is said to bear favourable comparison with steels produced by established methods.

Polyester/Glass Building Cradle

Polyester/glass has been used by Palmer's Travelling Cradle and Scaffold Company Limited, to make a building cradle which has several advantages over the conventional wooden cradles normally used. Cradles of this kind are used for conveying workmen engaged in cleaning and maintenance of all kinds of buildings, but require attention to avoid undue damage by weather and by cleaning fluids. Consequently, they have to be taken out of service at frequent intervals for repainting and general renovation.

The new polyester/glass cradle is not only resistant to weathering and



Pouring from the 1½ ton, 450 kW Birlec mains frequency coreless induction melting furnace installed at the works of Inca Steel Company Limited, Sheffield, where it is engaged in the production of high speed steel ingots

to cleaning chemicals, but is also easy to clean down and thus be kept in continuous service. In addition, the new cradle is lighter and more manoevrable and is not so fatiguing for the workman to operate. Finally, because the shell of the cradle is moulded in one piece it offers protection against the elements and is also valuable psychologically since it gives the workman a greater sense of security.

A prototype cradle has been made and tested extensively and the manufacturers are now going into production with a version incorporating modifications arising out of the experience gained during trials. The polyester resin used in this cradle is supplied by Bakelite Limited, and the glass reinforcement is Duramat supplied by Turner Bros. Asbestos Company Limited.

Computing System

A high-speed electronic computing system has been ordered by The Shell Petroleum Company Limited and will be used to solve complex mathematical problems which arise in the planning of economic activity. It will be installed in the company's London office and used for special calculations covering commercial aspects of all activities from exploration to marketing.

Based on the Ferranti Mercury machine with additional punched card, magnetic tape and high-speed printing units, the computing system will be one of the largest in the world to be used mainly for operational analysis. It will also be one of the fastest systems in Europe for electronic processing of data.

The equipment will be able to store the equivalent of more than 60,000,000 decimal digits at a time, and the computor itself will perform up to 16,000 individual operations per second.

The present order has been largely influenced by Shell's successful experimental work over the last three years on the Ferranti electronic computor in their Amsterdam laboratory. This has demonstrated that computors allied with new mathematical techniques can make a real contribution towards the analysis of intricate business problems, thus assisting management in deciding on the best course of action in complex situations.

The new computing system is expected to be in full operation early in 1959.

Inventors for Hire

There is a considerable body of inventive ability and a great fund of perfected inventions, all readily available to manufacturers, either to assist them in the solution of problems requiring new ideas or to provide items with new products ready for manufacture. Mr. R. O. Sutherland, General Secretary of the Institute of Patentees and Inventors, writes that a number of manufacturers have already brought their problems to the institute and as a result have benefited from the inventive resources of independent inventors. The institute has also been able to introduce to other manufacturers the inventors of marketable ideas, again to their mutual advantage. In matters of this kind the institute, which is an impartial and non-profit making organization, acts confidentially as an intermediary. The address of the institute is 207-8 Abbey House, 2-8 Victoria Street, London SW1.

Leather as a Packing Material

Although basically a natural material, modern hydraulic leathers are 'tailored' to suit specific service conditions by the utilization of selected impregnants. Improved tanning technique has also materially improved both the strength and heat-resistance of leathers. Typical types of leather packings and design applications are discussed

FAR from being rendered obsolescent by modern elastomeric seal materials, leather has shown a remarkable come-back in the field of hydraulic packings, both in its own right as a basic material and combined with other products such as synthetic rubbers and silicones for special-duty services. Basically leather is a unique material, probably more plastic than any other sheet material of comparable strength and also with the unique property of retaining its flexibility and strength down to temperatures well below minus 100° C. It also lends itself to 'improvement' by impregnation, e.g., resisting the penetration of a pressure medium or to enhance its resistance to chemical attack.

A good hydraulic leather is cut from the butt portion only of selected hides, the fibres in this section of the hide being more uniform and more closely interwoven. The process of tanning converts the hides into leather whilst maintaining, and even enhancing, the interlaced strength of the fibres. There are three main types of leather produced by different tanning techniques suitable for hydraulic application.

Vegetable tanned leather—also known as oak tanned leather—subjects the hide to a solution of vegetable tanning materials resulting in an appreciable swelling of the hide. It is a method of tanning dating back to the earliest days of leather production, although close chemical control in modern vegetable tanning produces a more uniform product and one where the properties can be adjusted, to a certain extent, to suit the particular application for which the leather is intended. The tensile strength of such leathers is of the order of 2000 psi, a major performance limitation for hydraulic packings and similar duties being that it is not suitable for service temperatures exceeding 122° F (50° C).

A somewhat superior leather is yielded by the mineral tanning process producing chrome tanned leathers. This process was first introduced in the nineteenth century but has only been used industrially during the past fifty years. The chief characteristic is that the fibres are more closely packed than in vegetable tanned leather so that it is far less permeable and also its tensile strength is higher. Limiting service temperature for chrome tanned leathers is 167° F (75° C).

Modern industrial leathers combine vegetable and chrome tanning to produce an even stronger, tougher leather capable of continuous duty at temperatures up to 300° F (150° C)—e.g., typical for chrome retanned leather. The tanning process promotes a definite shrinking and consolation of the fibres whilst retaining natural pliability.

Conventional leathers are a natural brown in colour. High-performance leathers may range from brown to greyish green in natural colour, although the final colour may be dependent on an impregnant or a dye deliberately introduced as a method of identification (e.g. many leather packings are dyed black).

Impregnation is done with hydraulic packings to provide a pressure seal, the impregnant chosen being selected on the basis of the grade of leather and its service application, flexibility required from the packing, service temperature and chemical effects of the fluid or medium to be contained. This leads to a wide variety of leather packings, each designed for a particular service application, and in many instances virtually 'tailored' to specific requirements. These may range from very soft leathers for low pressure work with gas as the working fluid to harder leathers and harder impregnants for chevron seals to withstand pressures in excess of 10,000 psi with liquids. Virtually the texture required of the packing, and thus the type of impregnant employed, is dictated by the pressure at which the packing or seal is to work.

Leather packings are moulded to shape in four basic forms—cups, hats, U-leathers and V-leathers—as well as cut as flat seals, diaphragms, etc. Because of its fibrous nature leather cannot be moulded to precise dimensions but the material has the inherent property of effectively sealing greater clearances than homogeneous and most fabricated rubber elastomers so that this is no limitation in use. It mainly imposes a limitation on production technique to ensure that the elastic limit of the material is not exceeded in moulding.

Whilst having high resistance to abrasion and scuffing, and also being able to accommodate itself to small irregularities, the surface finish of the moving part in rubbing contact with the leather packing should be of the order of 20 to 50 microinches (the lower figure usually recommended for minimum leakage and maximum life). This is consistent with the finish required for optimum performance with fabricated rubber seals

Table I.—TYPICAL DIAMETRICAL CLEARANCES
(Pressures up to 20,000 psi)

Plunger Dia.	Diametrical Clearance
in.	in.
1— 5	0.003
6—10	0.004
12—18	0.005
22—32	0.006
36 and over	0.007

Table II.—CLEARANCE BETWEEN PLUNGER AND CYLINDER
(Pressures up to 20,000 psi)

Plunger Dia.	Diametrical Clearance
in.	in.
1— 3	0.003
4— 7	0.004
8—10	0.005
12—18	0.006
20—24	0.008
28—36	0.010
40 and over	0.012

and packings and somewhat rougher than that which be tolerated by homogeneous rubber seals.

Excessive surface roughness will cause undue wear on the leather, as well as increasing friction, and may also lead to early failure due to elongation of the packing on one side. A common source of failure is with cast iron cylinders and water fluid. Cast iron tends to be abrasive and rapidly pits and corrodes in contact with water, further aggravating wear. A honed and polished finish is best with cast iron surfaces and the use of rust-inhibitors in the water to prevent corrosive attack on the smooth surface.

Elongation of the packing on one side can also result from improper support; lack of support on the shoulder of a cup, hat or U-leather can result in extrusion of the shoulder into the clearance space—see Fig. 1. Recommendations for clearances are given in Tables I and II.

The shape of the backing ring or gland ring is also important, it being determined by experience that a flat face is better than one shaped to give support

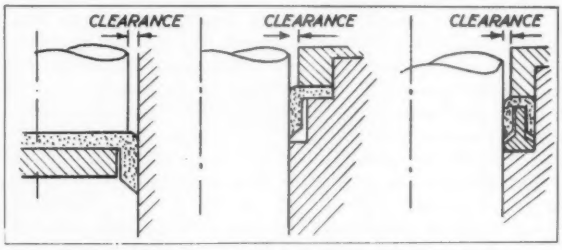


Fig. 1. Shoulder support requirements for cup, hat and U-leathers

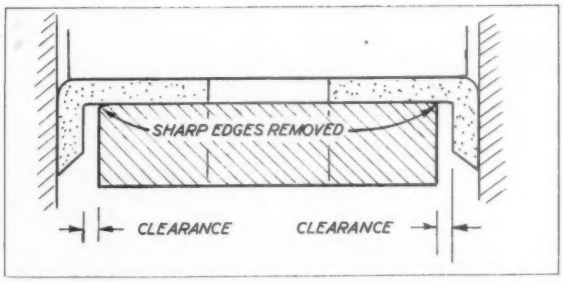


Fig. 2. Clearance requirements for leather packings (typical)

around the shoulder (as is often done with moulded and fabricated elastomeric packings). Even if the sharp edges so produced are rounded off there is always the possibility that they will wear sharp enough to cut the leather or alternatively, if well rounded, produce a cavity into which the shoulder will tend to extrude under pressure and damage the fibres. In practice a leather packing soon assumes the shape of the backing ring or gland ring and so with a square face the shoulder of the leather itself will assume a square form.

A definite clearance between the inside supporting plate or groove and the packing is necessary to accommodate a natural tendency for the leather to swell in contact with a fluid—Fig. 2. The degree of swelling will repend on the fluid and is rather greater with water than with oil. A suitable allowance is a diametral clearance of two-thirds the thickness of the leather in the case of water and one half the leather thickness with mineral oils. Other considerations to bear in mind are that moulded packings should be an easy 'plug' fit in the bore or groove, etc., and not oversize (requiring forcing in place resulting in possible damage to the fibres) or undersize (relying too much on the sealing properties of the feathered edge).

Typical cup leathers—Fig. 3—for central mounting range in size from a matter of $\frac{1}{4}$ in. dia to several feet; and in material specification to accommodate very low pressures up to pressures of the order of 10,000 psi. In general, however, large diameter cups are avoided for high pressure work owing to the difficulty of anchoring them securely in position. Large diameter cups, too, are generally held by a number of bolts equi-spaced on a bolt circle of about 0·6 cup diameter rather than a single central bolt.

The thickness of leather used for the cup is selected with consideration of pressure and service duties. The height of the cup is largely standardized for different

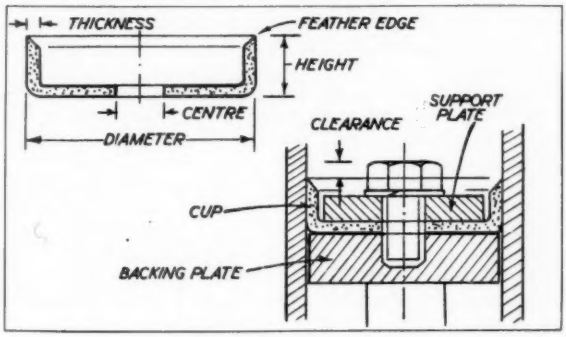


Fig. 3. Typical cup leather proportions

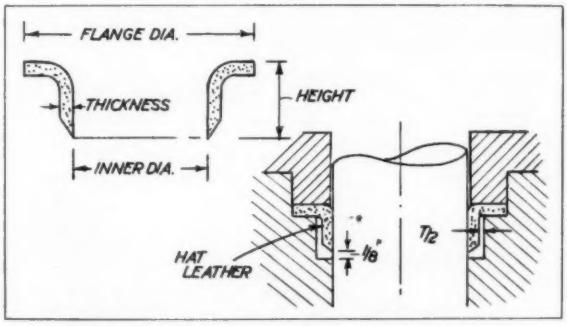


Fig. 4. Hat leather or flange leather for shaft or piston rod seal

diameters, being proportionately greatest with the smallest diameters. There is no point in increasing the height of the cup beyond that amount required to produce an adequate seal as this only increases friction. The edges of the cup are feathered at an angle of 60° (average) to provide additional flexibility and promote a positive sealing action under pressure. For low pressure applications the bevel angle may be decreased to give extra flexibility to the sealing lip.

In the case of double-acting installations a pair of cup leathers may be used back-to-back separated by a common backing plate. In installations where pressure build-up is slow it may be advantageous, or even necessary, to provide spring expanders to produce sealing at very low pressures, which may be of the coiled spring, finger or piston ring type. In addition to sealing with reciprocating motion, cup leathers are also

used successfully with combined rotary and reciprocating motion where the shaft is pivotally mounted on the backing ring and can rotate independently of the seal and clamping plate, taking care of the rotary motion whilst the seal undergoes a normal reciprocating motion.

Hat leathers or flange leathers—Fig. 4—are used primarily for internal sealing on a shaft or piston rod, particularly for small cross sectional areas where a U-cup cannot be fitted. The diameter of the hat should be slightly less than that of the recess into which it is fitted so that when clamped down it will expand slightly to form an effective seal, although excessive tightening may over-expand the heel and cause excessive friction and high wear on this part of the seal as well as causing the bottom of the seal to 'toe out'. Adequate clearance is required at the bottom of the recess pocket ($\frac{1}{8}$ in. is a standard recommendation) to avoid 'bottoming' the feather edge and the width of this pocket should provide a clearance space of approximately one half the thickness of the leather. The corner of the shoulder should also have sharp edges removed to prevent cutting of the leather.

Elongation of a flange leather on one side is usually due to insufficient clamping, either the gland not tightened up enough or the size of washer too small so that there is insufficient base area for positive clamping. Also where the gland is screwed into place instead of being bolted on, a gland ring is usually called for on top of the packing to obviate distortion when the gland is fitted and tightened up. As with cup leathers, spreader rings may be incorporated in the installation to maintain positive sealing at very low pressures.

U-leathers—also known as ram packings—are widely used for high pressure seals, but optimum efficiency is

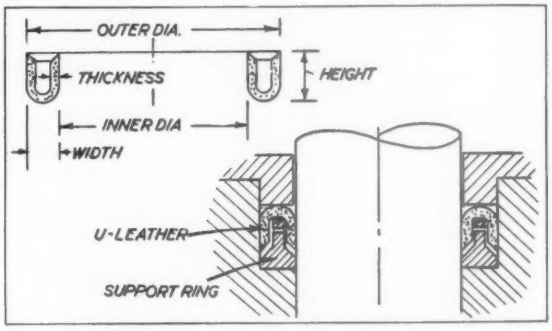


Fig. 5. U-leather for high pressure seal—must be supported by spacer rings or packed to provide internal support

achieved only by attention to installation details. The packing must be properly supported by a spacer ring which both maintains the ring in its correct position relative to the gland or back support and also keeps the side walls of the leather in the correct position for sealing—Fig. 5. Alternatively, where no ring is employed (e.g. with small sizes where space is limited) the recess inside the leather is filled with some material such as flax, leather or cotton to prevent the side walls from collapsing inwards. In other respects design details are similar to those for the installation of cup leathers.

The size of U-ring is chosen largely on the basis of experience, the width of the U-section being largely independent of diameter (similar to the height of a cup packing). Frictional characteristics, too, are similar to those of cup packings although sealing is improved for high pressures by the increased length of seal. The spacer ring is usually drilled through or perforated to ensure that full pressure reaches the outer lip of the section.

In high pressure installations the U-cup may be backed up with leather rings matching the packing recess and shaft in outside and inside diameters respectively, for the purpose of acting as anti-extrusion devices. U-leathers are also sometimes used as seals on rotating shafts, although performance in such applications is generally inferior to cup packings or V-leathers, except where the shaft diameter is small and rotational speed low.

The V-packing or V-leather is virtually a high-performance development of the U-packing where the section is chevron shaped (and consequently sometimes referred to a chevron packing or chevron ring). The V-ring is also ubiquituous in application, being suitable for both high and low pressures, and reciprocating and rotating shaft seals.

The normal V-angle is 90° and the ring is designed to be stacked, as shown in Fig. 6, between a male and female support ring in a suitable recess. The number of rings is determined both by the space available for the packing and the pressure involved. Three rings is a normal choice for pressures up to 500 psi; four rings for pressures 500–3000 psi, five rings for pressures 3000–10,000 psi, and six rings for pressures above 10,000 psi. V-ring packings are capable of working up to much higher pressures, even up to and exceeding 100,000 psi in certain installations although the normal maximum working pressure for a six-ring installation

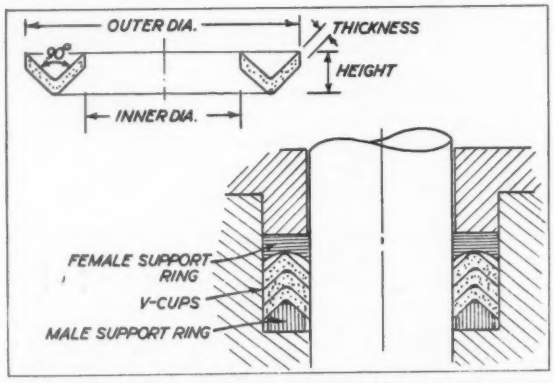


Fig. 6. V-leathers—used in sets for pressures up to 20,000 psi. Number of rings depends on maximum working pressure

is usually taken as 20,000 psi.

Sealing action is provided by the lips of the individual rings so that it is unnecessary for the gland or support ring to be tightened excessively as this will result in unnecessary friction and wear. On the other hand, in the event of partial failure of the seal—e.g. due to age—the full sealing action can generally be realised on a temporary basis by tightening up the gland to turn the packing into a compression seal.

The success of V-packings depends largely on correct support and correct clearances being incorporated in the assembly with, preferably, both support rings being made of metal for rigidity. Where necessary (e.g. for low pressure applications) the male ring may again be drilled through to feed pressure to both sides of the

seal, although this is not necessary if clearance is provided on both sides of the ring.

In double-acting installations it is more or less imperative to use a common female ring rigidly mounted on the piston (e.g. commonly turned as part of the piston) and packings mounted back-to-back (apex facing apex) in each set. Each set of rings then acts independently, according to the direction of reciprocating motion.

Properly installed, V-ring packings have a long life and low maintenance and can generally continue to operate satisfactorily under conditions which would rapidly ruin other types of leathers. Their ability to absorb wear, of course, also makes them more effective than the other forms for rotary shaft seals. A further advantage from the installation point of view is that rings can be cut, if necessary, to get them in position with the minimum of trouble. If the cut is made at an angle and the joints staggered on succeeding rings the efficiency of the whole seal is not impaired.

Oil-Firing Control

Starting and stopping equipment at Littlebrook—C Power Station.

A RELATIVELY simple system, for the control of oil valves, steam valves, dampers and igniters on the boilers at Littlebrook—C oil-fired power station, is obtained by the use of a six-position selector switch, two relays, power operated valves and other equipment supplied by Audley Engineering Company Limited, of Newport, Shropshire.

The requirement of the system is the sequence control of the operations associated with start-up, running and shut-down of each bank of burners from a specially designed control panel incorporated in a main control desk, a simplified circuit diagram for which is shown in Fig. 1.

When the boiler is to be brought on load, oil is re-circulated through a re-circulating valve to a point before the main oil feed valves which are isolated. Before the actual firing sequence commences on the lower bank of burners, the valve controlling the re-circulating oil is closed by a separate pushbutton on the panel.

Selector switches, of which there are two, one controlling the lower burner bank and the other the upper burner bank, control the following firing sequences:

1. **Start-up purge.**—When this position is selected, the steam valve is opened by SO (see diagram); steam is then blown through the lines feeding each burner to remove any coagulated oil, to ensure that the burner nozzles are clear and to heat up the lines prior to feeding oil. This operation is applicable to both the upper and lower banks of burners.

2. **Check re-circulation.**—The selector switch is stepped to this position and the operator then checks that the re-circulating oil valve is closed by means of a visual indicator mounted on the control desk. If this valve is not closed, no further operation will take place should the next switch position under heading 3, 'Running', be selected due to interlocks provided between the re-circulating valve and the main oil feed valve.

In the case of the upper bank of burners only, air dampers at each corner are opened by DO at this position on the switch. On the lower bank of burners at this point the ignitors at each corner are energized by means of a pushbutton on the control desk, but are not inserted into the furnace.

3. **Running.**—In this position the steam valve is first closed by SC. When fully closed a limit switch S3 is operated which causes the main oil feed valves to be opened by OO. When the main oil feed valve is fully opened a further limit switch S1 is operated to de-energize the solenoids by means of which these operations have been accomplished.

This sequence applies to both the lower and upper banks of burners. Ignition is obtained only on the bottom burner of each lower bank. Oil is allowed to discharge through these burner nozzles for a few seconds before the energized ignitors are inserted into the stream of atomised fuel. Operation of a pushbutton on the control desk inserts the ignitors.

As soon as ignition is obtained, a further button is pressed to retract the ignitors from the furnace.

4. **Shut-down purge.**—When it is required to shut-down, the selector switch is moved to this position. The steam valve is opened by SO and when fully opened operates a limit switch S2, which causes the oil flow valve to be closed by OC. The purpose of the steam purge is to remove all traces of oil from the line to the burners. The dampers on the upper bank of burners only are closed by DC at this stage. The oil re-circulating

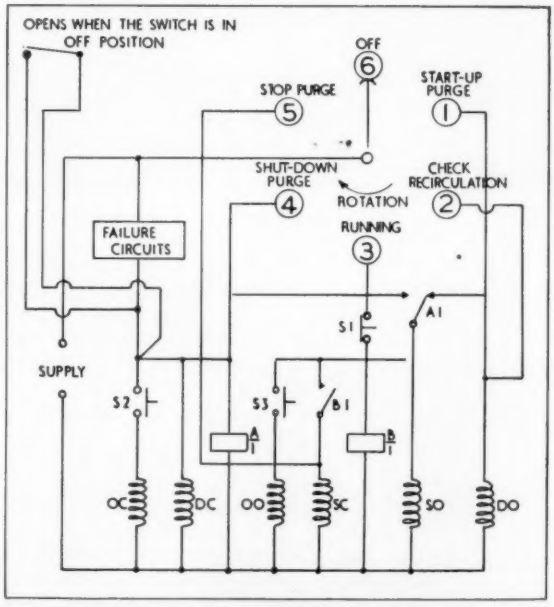
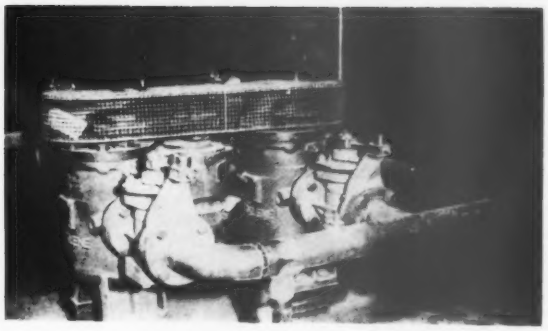


Fig. 1. Circuit diagram of control panel. Solenoids: DO causes dampers to open. DC causes dampers to close. SO causes steam valve to open. SC causes steam valve to close. OO causes oil output valve to open. OC causes oil output valve to close. Limit Switches: S1 opens when oil output valve is fully open. S2 closes when steam valve is fully open. S3 closes when steam valve is fully closed



Audco standard type valves fitted with mechanical interlocks

valve is then opened by the pressing of a button on the panel.

5. **Stop purge.**—This position causes the steam valve to be closed by SC.

6. **Off.**—With the switch in this position all circuits through the switch are broken.

Under certain circumstances, such as flame failure or forced draught fan failure, it was required to initiate the shut-down purge with the selector switch in the running position. Relays associated with these circuits are normally energized and in the event of any failure of flame, induced draught fan or forced draught fan, they are de-energized, closing contacts which initiate the shut-down purge.

Control cabinet

The 2 in. oil flow valves and the 1½ in. oil circulating valve were required to handle fuel-oil at 500 psi and the ¾ in. valve oil on one side and purge steam on the other. During the start-up and shut-down periods each oil and steam valve would have the two different fluids on either side of the valve.

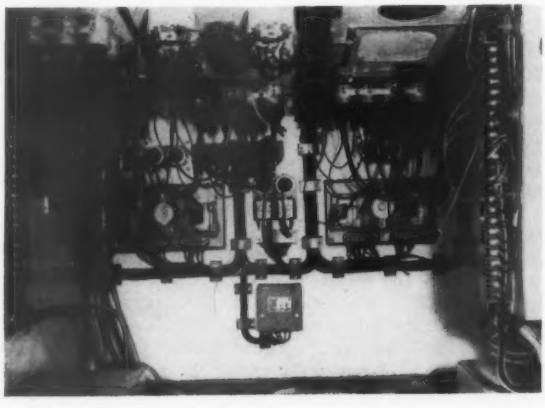
The Audco lubricated plug valve was selected for its suitability to this application. This valve gives free flow in the fully open position and a 90° rotation of the plug, which can be obtained by remotely controlled power operation, gives complete shut-off. The valve body is of carbon steel and the plug of hardened steel. The Audco Hypreseal design was used for this application, a feature of this design being that a labyrinth shank sealing is used, the plug being rotated by a screwed operating stem via an equaliser ring. The stem is sealed by a special plastic packing material which may easily be introduced while the valve is

Audco Hypreseal valve with trunnion mounted cylinder operator

subject to full line pressure. The plug is seated solely under the control of a ball-ended pressure screw and is independent of the end load on the operating stem due to line pressure.

Power operation of the valve provides rapid opening and closing with the plug remaining *in situ* in the event of operating power failure. The plug valve is inherently static in the absence of external operating torque and pneumatic operation was used to give the required operating speed. Each valve is fitted with a double acting, fully cushioned air cylinder which actuates the valve through its 90° movement by means of air at 80 psi, applied to the appropriate side of the cylinder piston. The rear end of the cylinder is fitted with a trunnion mounting, this being pivoted on a spindle which is mounted on a bracket clamped to the pipeline. This arrangement ensures that no torque is applied to the pipeline or its supports.

Each operating cylinder is controlled by a double solenoid-operated five-port balanced air valve, mounted close to the operating cylinder and feeding it via two flexible pipes. Double solenoid operation was selected so that



Control panel wiring

there would be no false operation of the valves in the event of an electric supply failure, also during normal running of the boiler it would not be necessary to hold any solenoids energized. An additional feature of this manner of operation is the simplicity of the sequencing control circuits.

Provision is made for manual operation of the valves by utilizing a stub projection integrally cast on the valve operating lever.

In addition to the Audco valves, sequence control of the dampers and burner igniters retraction gear is also required. In each case operation is achieved by double-acting pneumatic cylinders similar to those used for valve operation and as before the air supply to the cylinders is controlled by solenoid operated air valves. In the case of the dampers, double solenoid operation is employed, but single solenoid operation with spring return is employed for the igniters so that in the event of a solenoid failure, the igniters will retract to the 'safe' position.

The pneumatic cylinders are designed to give fast operation under normal operating conditions, but in the case of both the dampers and igniters slow operation is required. This is achieved by incorporating uni-directional flow restrictor valves in the air lines to the cylinder. These valves have an adjustable orifice to control the rate at which air can escape from the cylinder.

Switch boxes are mounted on all the Audco valves and adjacent to the dampers and igniters. These boxes contain two micro-break switches, one of which is operated when the associated valve, damper or igniter, is in either extreme position. These switches may be normally open or normally closed and are used either in the sequencing control circuits or for remote position indication by means of indicator lights on the main control panel.

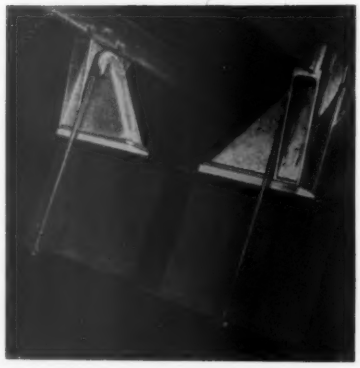
A further feature of the scheme is a system of mechanical interlocks associated with filters in the fuel oil supply lines. Two parallel filters are provided in each line and have an Audco valve on both inlet and outlet sides. It was required that one filter should always be in circuit and that, when it was necessary to take that filter out of service, the other filter must first be brought into service.

The interlocking was achieved by the use of Castell locks. Four keys are provided, one for each Audco valve, and at least two of these must always be in a key exchange box, the box being arranged so that the two keys for the valves associated with one filter only can be removed at any one instant. The lock provided on each valve is arranged so that the valve cannot be closed unless the correct key is inserted in that lock and in that manner no more than the two valves adjacent to one filter can ever be closed.

Cast Aluminium Vehicle Body Underframe Pedestals Save Fabrication Costs

Aluminium die castings are now being used in the construction of light-alloy commercial vehicle body-work to provide cross-bearer supports or "underframe stools" to give adequate rear-wheel clearance. Designs have usually been riveted fabrications of extruded sections and sheet material, but even when batched produced these squeeze-riveted units entail high costs in labour and material. A die-cast aluminium underframe pedestal, which is now available from Northern Aluminium Company Limited, Banbury, Oxfordshire, provides a unit ready for mounting, which should enable these costs to be considerably reduced.

One advantage over a fabricated unit is the reduction of fitting involved, namely three bolts between cross-bearer and pedestal and mounting the bearer assembly to the chassis with a U-bolt. The retaining groove for the U-bolt is so positioned to ensure that the pedestal is always in compression, thus making the best possible use of the properties of the casting,



Cast aluminium underframe pedestals in Noral 117 alloy

which is in Noral 117 alloy (B.S. 1490 LM4M). The pedestals may be fitted facing both forwards and backwards in order to resist braking and accelerating loads, but the majority should be fitted facing forwards in order to ensure that the more severe braking loads are adequately accommodated.

The 7 in.-high pedestal at present available, will, according to the bearer depth and the thickness of the chassis pad, give frame-to-floor heights of between 10–12 in. Two more pedestals having heights of 5 and 9 in. respectively will be available shortly to meet all the variations in underframe heights.

Coal-face Drainage Unit

A compact, portable, face drainage unit, specially designed to deal with small amounts of "nuisance water" at the coal-face, has been introduced by Megator Pumps & Compressors Limited (43 Berkeley Square, London W1).

Known as the Megator Puddle pump, the unit consists of a small version of the standard Megator M50 face drainage pump powered by a continuously-rated, flameproof, mining-type motor wound for 110 V, 3-phase, 50 cycles mounted on a mining-type base fitted with lifting handles. The pump will handle 8 gpm with a total head from all causes of 100 ft. A further feature of the Megator Puddle pump is that it gives interchangeability of spares with the Megator M8 dust suppression pump.

The new Megator Puddle pump

technique

devoted to the discussion of practical problems. Readers are invited to contribute items from their own experience in matters relating to design, manufacture and maintenance. Payment will be made for published contributions.

Any Questions ? We welcome inquiries concerning difficulties arising out of our readers' general work, for treatment in the **technique** section. The full name and address of the writer (not necessarily for publication) must accompany each communication

Avoiding Porosity in Welding

The problem of porosity is one which arises constantly in welding. Its effect in work which is subjected to X-ray is well known, but in work which is less strictly tested, visible porosity constantly necessitates laborious chipping-out and re-welding. Appropriate steps can, however, be taken to ensure porosity-free welds.

Often, the problem arises as a result of welding on greasy or painted plate. The plate should always be cleaned, at least along the line of the weld, before the welding operation commences. Plate which is very wet sometimes shows porosity, as does plate which is heavily rusted. This is particularly so if the rust has absorbed moisture. Wet plate should therefore be dried, and rust can be eliminated if an oxy-acetylene torch is run along the line of the joint. Mill-scale often contains a large quantity of sulphur and should be cleaned off before welding.

The correct choice of electrode plays an important part in the success of welding operations. A large variety of mild-steel and special electrodes are now available for welding various metals and alloys, and for joining two different metals.

Despite considerable research into welding problems, it is still found that some metals are difficult to weld. In particular, free-cutting steel, which contains a fairly high proportion of sulphur often gives porosity even when care is taken in both technique and choice of electrode. For the welding of free-cutting steel, a basic low-hydrogen electrode, such as Quasi-Arc Ferron, is advisable.

Porosity is also caused by dampness affecting the electrodes. Some coverings absorb moisture more easily than others and where electrodes are found to be damp even despite careful storage, a drying oven should be used which holds the electrodes at the correct temperature and avoids damage to the coverings by excess heat.

Care in technique must always be exercised. In inert gas shielded welding processes, it is important to see that the correct gas flow is ensured before the welding operation commences. Insufficient flow or failure of the gas supply will result in serious porosity.

Basic low hydrogen electrodes generate a gas shield which is essential to protect the molten metal from the atmosphere. If this shield is diluted, porosity may result. At the start of the weld, and at points where a long arc has inadvertently occurred, porosity may therefore be present. The use of the "run-back" technique together with the holding of a short arc will eliminate this. It is also advisable to erect wind shields when welding is carried out in the open.

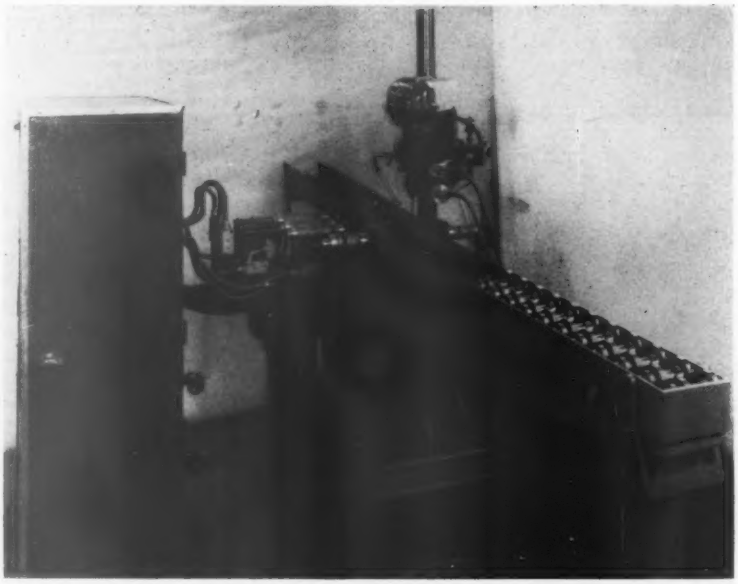
Trapped air or moisture in T-fillets or at other unwelded interfaces can also lead to porosity. Where areas of porosity occur despite the exercise of perfect technique, this is due in many instances to the fact that air or moisture has become trapped in a fillet, or behind tacks in a joint which already has a backing run.

Automatic Drilling and Handling

The machine illustrated works automatically in conjunction with a previous turning operation and a following grinding operation on the component and is therefore situated in the production line between an automatic lathe and a grinding machine. The components are cluster gears and the operation is to drill one $\frac{3}{16}$ in. hole radially through the component, breaking into the centre bore, to form an oil lubricating hole.

The method of operating the machine is as follows:

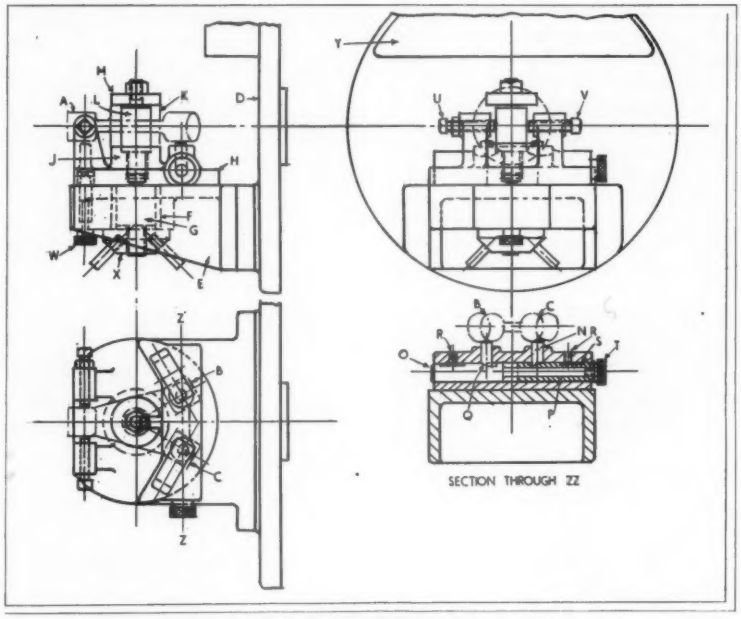
The operator controlling the automatic lathe places the turned component into the left hand side of the feed chute. The components then



Meddings automatic drilling machine

drop one at a time by gravity into the feeding station. The selection of the component is undertaken by electrically controlled pneumatic cylinders. When the component reaches the drilling station it is lifted up into position and then pneumatically clamped. On the completion of the hole being drilled, the drill spindle automatically retracts. Once the drill spindle has retracted from the component the side clamping cylinders are released, the component is lowered and then automatically fed to the right hand delivery chute. The cycle is then automatically repeated. This particular arrangement enables the drilling of this component to take place automatically without a labour charge for the operation.

For clarity the photograph shows the machine with all the guards removed; these guards protect the double acting cylinders, cams, microswitches, etc. The cycle time for this operation is set to keep in step with the two other operations. The equipment was designed and produced by W. J. Meddings Limited.



Lathe faceplate fixture for a special lever

Lathe Faceplate Fixture for a Special Lever

The accompanying illustration shows a faceplate fixture for drilling, reaming, and facing the three bosses A, B and C, of the special lever shown in shaded outline.

The fixture itself consists of a circular back plate D, having a spigot which is a snug fit in the corresponding recess in the faceplate of the lathe, and carrying an angle bracket E. This angle bracket is bored out vertically and bushed at F to receive the pivot G of the indexing plate H. The indexing plate H is provided with a boss J so positioned as to centralize the component from the central boss K of the special lever. A locating stud L carried in the boss J positions the component on the lathe centre-line and a horse-shoe washer M and nut form part of the clamping arrangement. Two adjustable jack pins N support the two bosses B and C. A section through ZZ shows clearly how this adjustment is obtained by means of an adjusting screw O and bush P, each being provided with an inclined surface Q to match the lower end of the jack pins N. Screws at R and keyway S serve to control the radial position of O and P. A knurled nut T is used so that the components cannot be sprung.

The radial position of the component is controlled by the setting screw U and locking screw V, which also support the casting close to the boss being machined.

A spring loaded plunger W carried in the angle bracket gives an efficient indexing arrangement. The indexing plate is locked, after indexing, by means of the large nut X.

The whole fixture complete with component is balanced by means of the segmental weight Y.

Synchronized Control of Compressed Air Motors

A method of providing simultaneous control of the compressed air driving motors at each end of a face conveyor, developed by Messrs. H. E. Thompson and G. Greenop, respectively colliery engineer and foreman fitter at Haig Colliery, Cumberland, has been used with success at that colliery.

A control panel is fitted at each end of the conveyor. Separate air supply mains are provided for each motor, and the controls at each end of the face are operated by levers which actuate a control valve connected to the main air supply. The throttle valve of each motor is operated through a link mechanism by a piston moving vertically in a cylinder. Movement of the valve is achieved by admitting compressed air into the cylinder, either above or below the piston, through the operation of the control lever. The control valve also regulates the supply of air to two pilot control tubes, each of $\frac{3}{4}$ in. dia, which are laid along the face and connect respectively with the top and bottom of the cylinder, controlling the throttle valve in each control panel. Thus operation of the control lever at one end of the coal face introduces compressed air into the control cylinders of the panels at both ends of the face, and thus the throttle valves of both motors are actuated simultaneously.

Normally the control lever at the far end of the face from the operator is locked in the mid-position. Should this be moved inadvertently to the "run" position it will not actuate the starting mechanism while the lever on the other panel is at "stop". This safety measure is achieved by providing the control valves at each end with hollow spindles; the air in the system is immediately exhausted through the hollow spindle if the valve is at the "stop" position. Similarly if one operating lever is locked in the "stop" position during conveyor maintenance operations the mechanic is automatically safeguarded against the machine being started from the other control point.

Cutting Teeth on a Large Cast Gear

The large cone shaped gear seen at Fig. 1 presented a rather unusual problem in that there was no flat machined surface against which to take the cutter thrust during gear cutting because of the cast cam track on one side, and a series of small bosses of uneven heights on the other face; the latter had they been milled would have varied sufficiently to make adequate support on some portions of the face problematical. Similarly the existence of these projections made it impossible to utilize any form of machine support either above or under the gear; hence it was decided to employ several plungers spaced at intervals round the periphery and lock them with the usual hand screws through bosses on the side of the base.

Fabrication, using black material, simplifies the construction of these large yet comparatively simple fixtures, and in this instance it meant welding a piece of flame cut circular plate to a round billet of steel; neither was pre-machined other than to skim the under face of the latter item, and

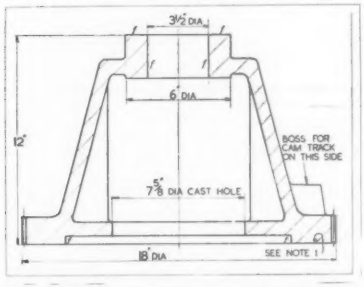


Fig. 1. The component, which needs adequately supporting during the gear cutting process because of the lack of a suitable facing to take the tool pressure. Note.—A series of small bosses cast this side of uneven height make it necessary to employ spring plungers for support during gear cutting

to incorporate a 45° bevel to assist the penetration of the weld. The bosses mentioned earlier were included, and these were spaced approximately equally around the circumference.

Fig. 2 illustrates the fixture. The tapered bush C which is previously inserted into the machine table hole, locates the fixture by registering inside the bush F; the latter is optional as a plain hole in the bottom of the fixture will perform the same function. However, if the fixture is frequently used, and this usually means removing it from the machine table sometimes two or three times a week, the bush is preferred because case hardening it preserves its accuracy for long periods.

The design of the component makes it necessary to support it on the 6 in. dia boss inside the casting, consequently a long extension on the locating spigot B is required to provide a solid support against the clamping pressure of the long stud H.

Arranging the component in this manner means that it does not sit on the inner face made when turning the lower recess, thus the larger diameter of B positions the casting on the fixture and the actual seating is on the top face. Such a practice makes it essential to include further support, and this is where the plungers are important; they take the complete thrust exerted by the cutter during the gear cutting process.

The spacing of plungers when they have to perform a task of this nature needs care. If they are too far apart much of their effectiveness is lost, and

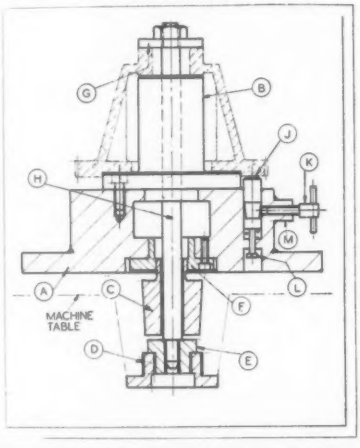


Fig. 2. A cross section through the fixture illustrating the method of centralizing it on the machine table and the position of the support plungers round the periphery A, fabricated base. B, locating spigot. C, tapered locating spigot in machine table. D, lower screwed bush. E, lower bush for stud. F, hardened bush in fixture plate. G, clamping collar. H, stud. J, plunger. K, plunger locking screw. L, plunger retaining screw. M, bosses welded to base member

though this does not mean that the operation is a failure, there is always the risk of vibration that can mar finish and accuracy. Incidentally, the locking of the plungers is possible by means of two or three screws instead of one for each, but because the process of cutting the teeth was rather lengthy in relation to the clamping time, the extra few seconds needed for tightening the screws was not important and the design seen here was simpler than using a complicated locking arrangement. Attention is, however, necessary when releasing a component to make sure the plungers are also released for the next casting prior to clamping the top nut, as failure to carry out this can result in distorted if not broken castings.

The cutting of comparatively deep teeth means that considerable material is machined away—heavy cutting pressures as a result can tend to move the component on the seating, hence the need if possible for a driving pin locating in a previously drilled hole. The latter is not always available, and this example is a typical instance where reliance is placed on the central nut and stud for holding the casting securely, and a really large member is required in case of movement. Occasionally resort is made to drilling a hole in a web or facing despite the fact that this may not appear on a component drawing, and there are no openings through which clamps can be used instead of the centralized nut and

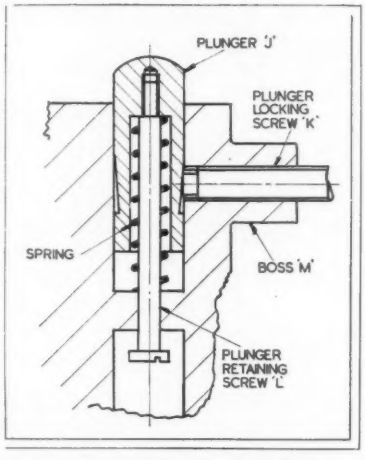


Fig. 3. Simplicity is the keynote with this type of plunger, and makes this design most efficient

stud. Such tactics are employed as the description suggests, when the gears are so large that the leverage caused by the cutting pressure is too much for the single nut and a tendency to turn under the cutting load makes it impossible to hold and drive it by the method shown here. A hole drilled to match a pin inserted in the fixture can simplify the driving problem and allow quite a small nut and stud to perform the clamping pressure.

This fixture was employed on a Maag gear cutting machine, and it followed the usual design associated with this type of equipment—no attempt was made to create a light base, but the emphasis was rather on simplicity as a good bulk of metal is preferable to counteract the heavy

vertical cutting loads. A feature with most gear cutting fixtures is their complete freedom from swarf troubles—the example shown here illustrates this point very well because no cuttings can penetrate to the lower tapered location, and the plungers also, if they are made a close fit in the holes, do not allow dust or lubricant to enter and so cause stickiness and a general refusal to operate until a complete dismantling has been undertaken.

Another point not at first apparent is the large flange turned on the locating spigot B. Instead of relying on large bored hole to position the spigot, a much smaller bore is used and this means the wide flange eliminates the top heavy effect which clamping so far from the lower surface seems to bring about. A wide flange and three holding screws makes such a condition impossible.

Fig. 3 shows the plungers. The design is simple and there is no doubt that this method of locking with the screw K and the way the screw L are part of the design makes this layout the best for this type of equipment. Usually the plunger is hardened on the tapered portion where the clamping screw contacts, and also on the upper radial surface which eventually contacts the component. The latter is really essential when the rough surfaces of castings need supporting as these can soon cause heavy wear and damage to the fixture details.

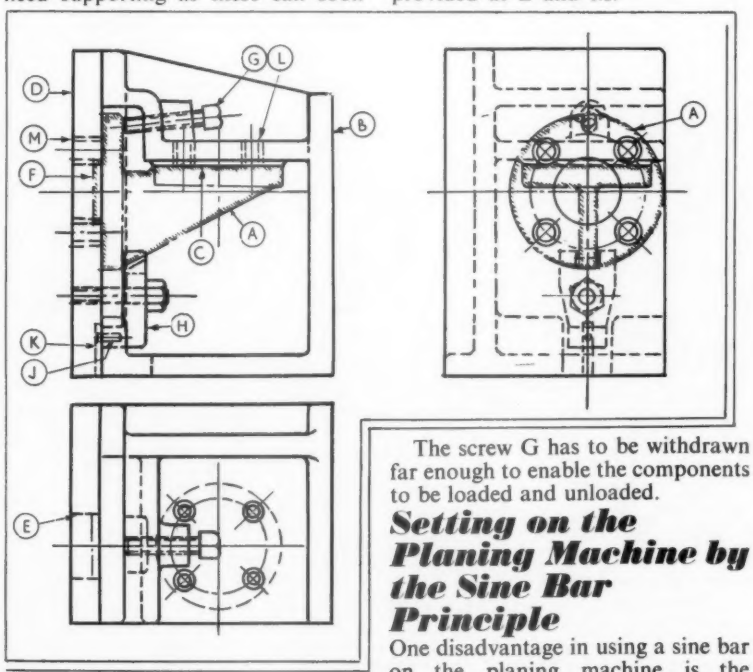
Some eight thousand gears were cut with the aid of this fixture before the component design became obsolete, and during that period no repairs or replacements were needed; conformation that the cutting method was efficient.—**J. A. Waller.**

Drill Jig for a Special Angle Bracket Jig

The accompanying illustration shows a drill jig for a special angle bracket, (shown with shaded outline at A). The jig is of open box type construction and consists of the main casting B which has a machined face C to locate one circular flange of the component. A drill bush plate D is screwed and dowelled to the main casting and from the inside machined face the component is squared up relative to the face C. A bored hole E in the drill bush plate gives centralization to the component from its spigot F.

Clamping is by a square headed screw G and a slotted finger clamp H (which should be provided with a spring to facilitate loading and unloading). A pin J in the heel of the clamp, in conjunction with a keyway K, controls the parallel movement of the clamp.

The necessary drill bushes are provided at L and M.



Assembly of drill jig

The screw G has to be withdrawn far enough to enable the components to be loaded and unloaded.

Setting on the Planing Machine by the Sine Bar Principle

One disadvantage in using a sine bar on the planing machine is the question of length—some jobs are comparatively short while others are perhaps several feet in length; thus either the bar required is long to eliminate possible errors or a long bar is applied for a short component, and this means that the table is traversed unnecessarily during the setting process.

The blocks shown in Fig. 1 were designed to simplify this work and though they employ the principle of the sine bar, the actual bar with the fixed centre distance is no longer used. The drawing is a plan view of the planer table and shows two blocks, A and B, which are made a tight push fit in the table slots. Vees to receive rollers are milled and subsequently surface ground in the blocks, taking care to make the apexes identical in the dimension X. A small diameter T-bolt holds each block to the table.

The blocks are ground accurately from the vee to the outside edges to establish dimension Y, so that by using gauge blocks or slips between the two pieces an accurate position is obtained from which, with a known diameter of roller, calculation will give the angle for the component.

Fig. 2 shows the general shape of the blocks and their form is easily variable providing the thickness that locates inside the machine slot is maintained to a tight push fit. There is no need to make the blocks high and between 1 in. and 2 in. above the planing machine table surface is ample. Finally while most table slots are of a standard width, continued use may have damaged them or caused wear, but this is soon corrected by re-machining either all the slots to another known dimension or just the two outer ones as it is these that are generally used for setting.

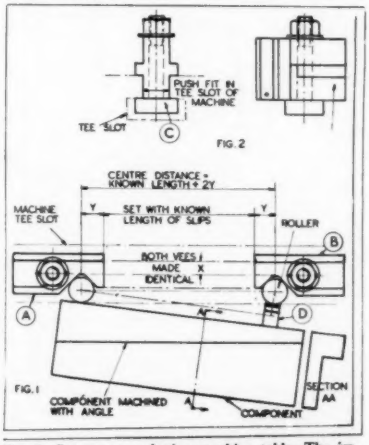


Fig. 1. Set-up on a planing machine table. The important dimensions are indicated and should be accurate to 0.0005 in. Fig. 2. The actual shape of the blocks. Dimensions can vary but a height of not more than 2 in. above the table surface is suitable

Producing a Drum Assembly

Assembly methods on presses are generally limited, but securing two parts together either by staking or clinching presents few problems. In this example bulging is performed to provide a stop face against which the drum rests prior to attaching it finally to the hub detail; the operation however requires a fairly elaborate tool for such a seemingly minor workstage—a two-part punch is essential to avoid complications during manufacture

By JOHN WALLER

SIMPLE looking designs are often deceptive because it generally means that in order to produce such articles the tooling equipment assumes elaborate proportions, and it may involve several operations which differ considerably from each other yet require performing in a definite sequence before the desired result is achieved.

Fig. 1 illustrates the assembly drawing of a special brake drum—other details were necessary in the complete build-up but the two parts in question demanded the most elaborate tooling methods, and though both items are circular the work included drawing, forming, piercing and the unusual process of bulging before the final operation of clinching was possible. Initially the drums were die cast but the soft material did not give satisfactory life, and replacement by a steel drum became essential. A fairly hard steel was chosen, about $\frac{1}{16}$ in. thick, and this was passed through straightening rolls before entering the blanking, drawing and forming tool seen at Fig. 3. Some idea regarding the actual size of this drum is obtained from the detail drawing portrayed at Fig. 2, and this indicates that a series of side holes were necessary as access apertures

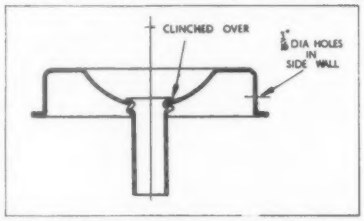


Fig. 1. Assembled drum showing the clinched-over centre hub, and the side holes already pierced in the walls

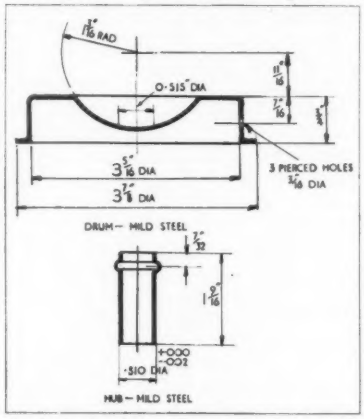


Fig. 2. Details of the two parts that make up this assembly. Both items are produced from steel strip

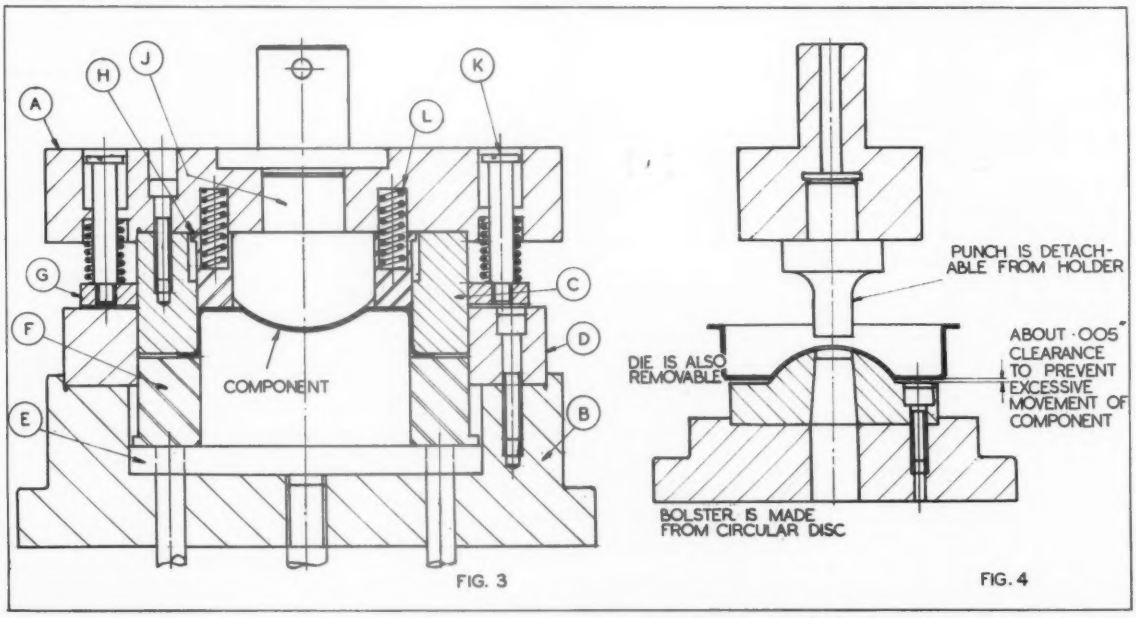


Fig. 3. The tool for blanking, drawing and forming the drum. Roll straighteners are employed outside the tool to ensure the material is flat before blanking. A & B, bolsters. C punch and draw die. D, die. E, forming punch. F, pad. G, stripper. H, pad. J, punch. K, spring and screw. L, springs

Fig. 4. A simple tool is used for removing the centre piercing as these differ in several designs

for inner parts during the building of this machine.

The design of the tool as seen at Fig. 3 follows orthodox lines—the material is initially held in contact with the die face by means of the pressure pad cum stripper G, and the descending punch C together with the die D severs the circular blank. Further downward movement carries the latter over the forming punch E, and in order to prevent distortion of this shell a fairly high pressure is exerted by the lower pad F; the steel blank is thus held securely and is allowed gradually to draw from beneath the two items until the drum assumes the shape indicated by the heavy line representing the component. Just prior to the press reaching the bottom of the stroke, the upper forming punch J produces the dished impression—a little stretching of the material is attempted at this stage, but this is not detrimental to the drum and also helps iron out any small wrinkles that may occur despite the use of the pad mentioned above.

For ejection the rising pad F lifts the drum clear of the drawing punch E and a spring loaded ejector H is used to strip the drum from the upper punch C, and heavy gauge coiled springs are necessary to ensure a positive ejection at every press stroke. The flanged punch controls the movement of these springs and the punch does not play the role of a normal pressure pad in this case as the drawing pressure ensures that the flat surface of the shell does not wrinkle. This pad is thus simply an ejection device to overcome any tendency of a drum staying in the upper member as the ram rises.

Because several different types of drum were needed having varying centre holes, a separate hole for the hub was necessary, and piercing tools of rock bottom simplicity were used. A typical example is seen at Fig. 4: the formed drum is placed on the lower die in the conventional manner and a small pressure pad holds it while the piercing process takes place. The die is arranged in this way to make resharpening easy, an internal radius gives a negative cutting edge—another reason for adopting this method for the die—and the tiny burr thrown up by the cutting action is afterwards flattened by the clinching tool and does not contact the shouldered portion of the hub.

The production of this latter detail introduces a workstage not often encountered: bulging suggests considerable alteration to the profile of an article, but in this instance only a slight rim is formed to provide a stop for the drum detail. The initial blanking and drawing processes follow in the usual way of making this class of item—a strip is fed through the tool seen at Fig. 5 and this severs a blank of calculated dimensions which is then carried down into the lower tool over a centre punch A. The die D is this time incorporated in the lower bolster. A lower pressure pad C holds the severed material between the top surface and that of the die B and it also serves the dual role of removing the drawn part from the punch. Inside the die is a simple ejector—the long spring is made sufficiently strong to strip the shell as the ram rises—and to obtain enough space for this part the stalk which fits the ram is recessed for the purpose. This comparatively narrow strip is guided through the tool by a built-up guideway, and there are varying methods of accomplishing this task; the design indicated in this drawing is, however, the most efficient way of providing a long bearing for the strip and is preferable to using headed pins.

A re-drawing operation is next performed on the tool illustrated at Fig. 6 and this means that the cup is placed on the pad A which surrounds the central punch B and is operated by three pins that pass up through the lower bolster and are actuated by the usual pneumatic cushion under the press.

One essential detail in this

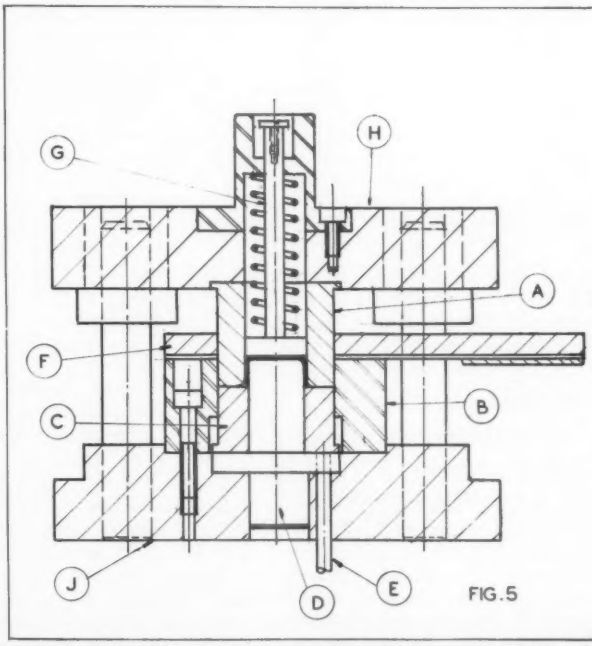


FIG. 5

Fig. 5. Orthodox blanking and drawing is used for the hub portion, and this tool forms the initial cup. A, blanking punch. B, blanking die. C, lower pressure pad. D, drawing punch. E, ejector pins. F, material guide. G, ejector. H & J, bolsters

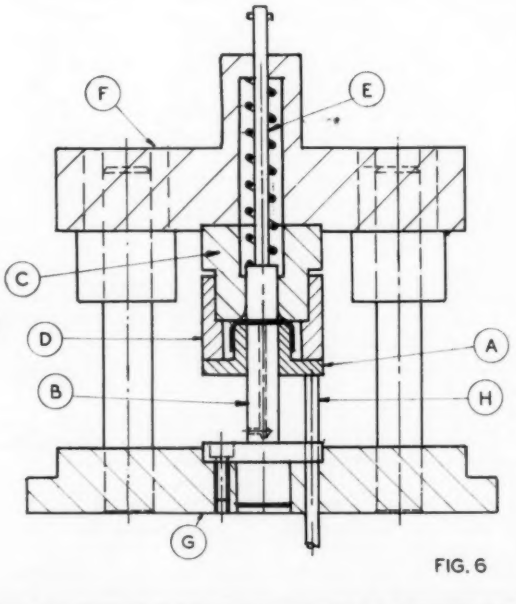


FIG. 6

Fig. 6. Re-drawing is essential before the required depth is reached. The tool illustrated here again follows orthodox lines. A, locating and drawing pad. B, punch. C, drawing die. D, ring. E, ejector. F & G, bolsters

punch is worth noting—the hole which prevents air from being trapped under the shell should the latter fit the pad closely, and the cross drilling of a short hole to meet the long vertical drilling to allow the escape of air as the ram descends.

The drawing die C is in two parts. The portion that re-draws the cup has the usual radius at the mouth and is also ground on the outside diameter to fit another ring D. This is used to push down the lower pad A against the pressure exerted by the pins, and making the part in this manner overcomes the problem of the awkward grinding operation which a solid detail would create. An ejection device identical in design to the previous tool is again employed in this member, and the opportunity is taken to show two methods of holding these ejectors to prevent them from falling out of the upper assembly.

While a tube would appear an easier solution to the problem of making this hub, the production commenced when that kind of material was difficult to obtain in sufficient quantities to assure continuous output, whereas strip was at that time readily available; hence, though it meant additional handling, this was not serious as a mechanical feeding mechanism allowed the press to run with only cursory attention on the part of a single operator, and as tube needed cutting to length on a capstan there was little if any saving between the two methods.

The bulging process is really a flattening operation, and an effort is made partially to collapse the article at one end. However, prior to inserting them into the tool at Fig. 8, the ends are trimmed by cutting off the floor. The setting is accurately accomplished on a small capstan and the disc removed is used on another assembly as a flat blank. Thus this apparently waste material is turned to good use and the tool and workstage for making such a disc is unnecessary. A sketch showing the tool removing the disc from the completed cup is portrayed at Fig. 7.

Returning to the bulging equipment, the trimmed cup is stood inside the die E and it becomes apparent that initially the lower stop and ejector F is in the 'up' position with the head bearing against the underneath of the die. Again the punch is made in two parts to facilitate production and the brief cross section of this item in Fig. 6 illustrates how this is carried out. This design of punch makes it easy to grind the floor in the upper portion and so secure the correct dimension from the top end for the actual bulge.

The first action of the tool as the ram commences to descend is to push the tubular component down farther into the lower tool; the punch merely presses against the tube and this action causes the part and the ejector pad gradually to sink into the bolster until eventually the flanged edge of the pad comes into contact with the recessed portion of that item. The flange and the position of the die E restrain the pad, and the spring is held by the strap which is in turn secured to two pillars as shown.

Immediately the tube ceases to move (the pad must eventually

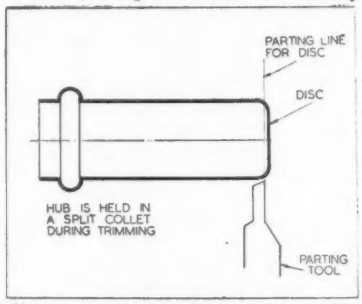


Fig. 7. The trimming operation for the end is not a wasteful one because the severed disc is utilized in a later assembly

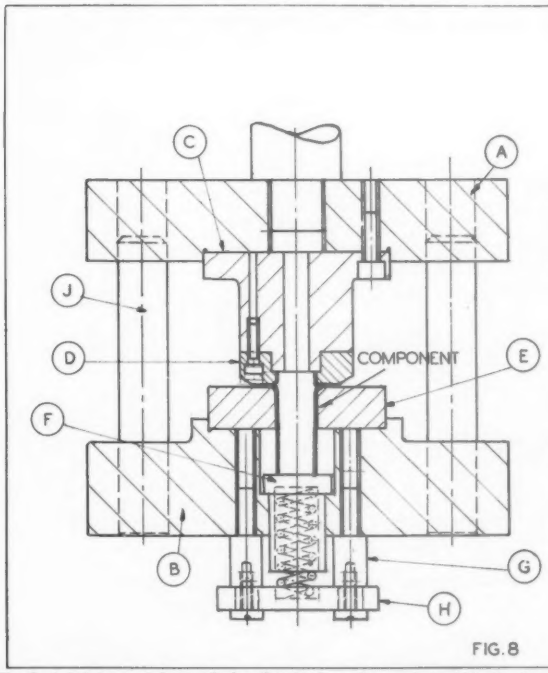


Fig. 8. A bulging tool for producing the circular collar against which the drum seats, requires the tube to seat before the final blow. A two-part punch ensures easy manufacture for that detail as shown here. A & B, bolsters. C, punch holder. D, punch. E, forming die. F, stop and ejector. G, pillar. H, strap. J, pillar

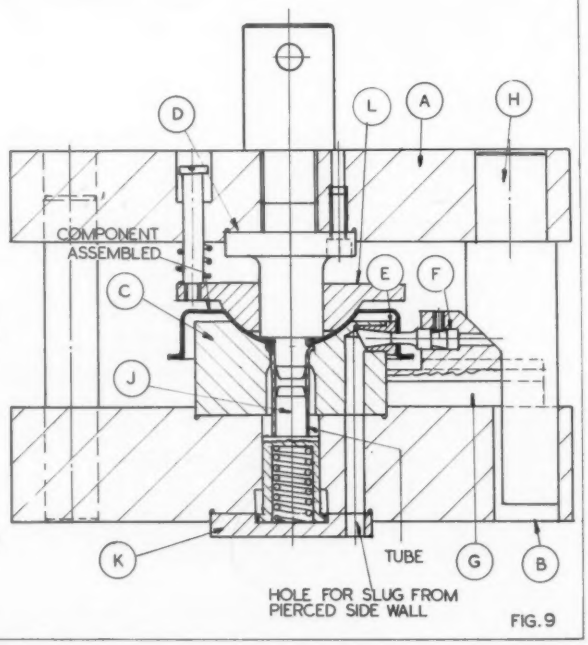


Fig. 9. Clinching the two details. Side piercing is done prior to the hub being turned over. A & B, bolsters. C, die. D, punch. E, die. F, punch. G, slider. H, cam. J, ejector. K, cover plate. L, bolster

bottom in the bolster) a slight further movement of the punch takes place and the inner surface of the recessed punch exerts enough pressure on the tube to cause the side wall to move outwards or collapse and the ridge is created as illustrated in the detail sketch of this workpiece.

The upward motion of the tool released the flanged pad and this detail lifts the tube halfway out of the die, enough to allow an operator to remove it by hand and as this lower section is not in any way distorted by the bulging, this process is not difficult. The weight of the tube prevents it sticking in the upper punch, but any that remain there are easily knocked aside before allowing the ram to descend.

The final operation of clinching the parts together is depicted in Fig. 9, and this tool also pierced the side holes which are needed for access purposes in the rim of this drum. The holes are not important as regards position or size, but piercing them in this operation avoids another tool and setting.

First the tube is located on the inner ejector J arranged in the lower half of this tool, and procedure is similar to the previous example in that a heavy coiled spring actuates it and permits the piece to act as a locator and ejector at the same time. Next the drum is set over the tube. The drum hole is pierced some 0·005 in. larger than the tube to facilitate this, and provided the drum locates over the hub the descending tool eventually pushes it down in contact with the bulge in the latter item.

A shaped pressure pad L attached to the upper tool in the conventional manner first contacts the drum and makes sure that the item is set against the curved location, but as this is being accomplished the side punches are already beginning to advance toward the side walls of that article, and they are arranged to pierce the holes just before the clinching tool D strikes the end of the tube. A perusal of this drawing will explain this. The side punches F are held in a sliding block G which is in turn operated by the long leg-shaped cam H.

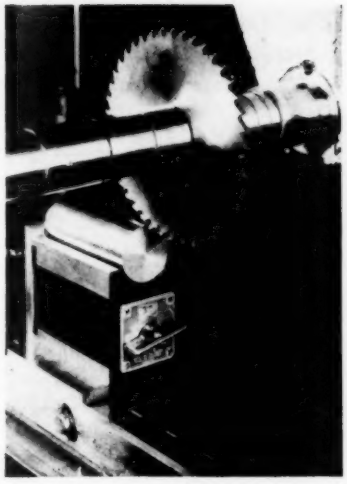
A good 'bump' is essential to set the projecting portion of the tubular article securely against the drum, and some care is necessary in order to avoid damaging the press or tools. As the press rises, the spring loaded locator cum ejector lifts the completed assembly partially from the die and as an operator can easily grasp the drum, it becomes a simple matter to remove it from the die without resorting to further mechanical aids.

Slug clearance can create problems for tools of this type. In this particular example only just enough room is available to allow the insertion of a die E and at the same time permit a drilling though the bolster for the piercings to fall away under the press bed. A drum with a smaller rim diameter would make matters difficult and cause a change in the design to let the slugs fall away in an angular direction, and this often means either further drilling or additional milling. The maximum size hole is drilled in this tool because in the event of a slug turning sideways and jamming across the hole, immediate packing would occur when further piercings dropped through and in a few moments this could cause the punches to fracture. Thus the drilling is as large as possible to make sure that when a slug does fall it cannot jam. Headed dies are provided as this simplifies re-sharpening and overcomes the necessity of having the large forming die a close fit inside the curved surface of the drum.

From these drawings and notes it becomes readily apparent that this simple looking assembly demands considerable tooling. A fair amount of detail is omitted in an endeavour to show other particulars clearly, but they do emphasise the importance of choosing the correct material and method of production at the initial stages. Die casting with the accurate reproduction of detail is a cheap and easy way of manufacturing certain articles, but where a heavy degree pressure occurs there is no doubt that steel parts produced by pressing as shown here, gives a superior assembly though it may take longer to manufacture.

Magnetic V-Block Simplifies Cylindrical Work Holding

The use of clamps and V-blocks to hold cylindrical work during machining operations is a long established engineering practice. The introduction of a magnetic V-block which will in many cases obviate the need for additional clamping should therefore find ready acceptance for the many jobs within its capacity.



Light milling operations can be carried out on suitable workpieces into which the maximum amount of magnetism can be induced. Note that the end stop is also being held magnetically

With the Eclipse magnetic V-block designed by James Neill and Company (Sheffield) Limited, Napier Street, Sheffield 11, both contact faces are magnetized by a turn of the switch so that the work secured in the appropriate V-slot, and the V-block itself is firmly applied to the machine table. At the same time, as the end of the block is also energized, work can be mounted vertically by turning the V-block on its end, using either or both V-slots as necessity arises in the upright position. This feature also allows end stops to be held magnetically when the block is used in the horizontal position.

The maximum capacity of the larger vee is $2\frac{5}{8}$ in. but this can be opened out by machining if a slightly larger capacity be required. The smaller vee is made to accommodate $\frac{7}{8}$ in. dia, thus allowing better access to work of small diameter. Whilst primarily designed to hold round work, rectangular and other sections can also be securely held. The magnet power unit employs Eclipse Alcomax flux-control which offers the optimum clamping power and magnetic efficiency.

The size is 4 in. long × $2\frac{3}{4}$ in. wide × $3\frac{3}{4}$ in. high and can be supplied in single units packed in polished wooden case at a cost of £11/5/- each or in matched pairs packed two in a polished wood case £23/10/- per set.

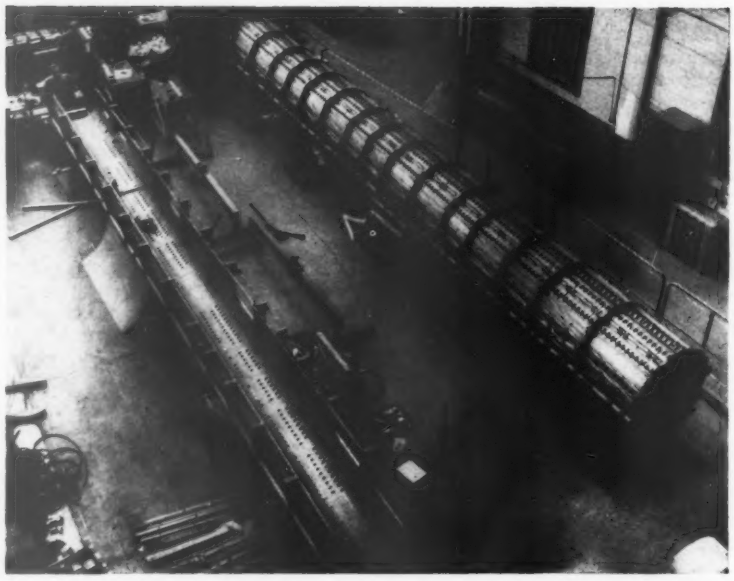
Nuclear Research Equipment

The novel feature of the tandem accelerator designed (in collaboration with the U.K. Atomic Energy Authority) and manufactured by the Metropolitan-Vickers Electrical Company Limited, is that acceleration is achieved in two stages. Negative hydrogen ions are first accelerated from earth potential to an energy of 6 MeV. They are then fired into a stripper that removes the electrons from the outer shells of the atoms and leaves the ions still moving in a forward direction with a net positive charge but with almost unchanged energy. The second stage of acceleration is achieved in bringing the positive ions back to earth potential, so that the total energy communicated to the ions is 12 MeV. In this way ions are accelerated to an energy twice as great as could be achieved in a single stage, but the insulation problems remain exactly the same as for a single-stage machine.

In this type of accelerator the ions may move distances of about 120 ft before reaching the target, and since it is required that the target area should not exceed a few millimetres in diameter, it is thus necessary to maintain a very high vacuum throughout the entire ion path and also to control all the accelerating and deflecting fields to a high degree of accuracy. 14 in. mercury diffusion pumps will be used to pump out the accelerator tube at the top and bottom and also via a by-pass tube at the centre. The accelerating, focusing and deflecting fields will be controlled by electronic stabilizers to an accuracy of a few parts in 100,000.

The equipment will considerably extend the range of studies that can be carried out with electrostatic generators and the higher available energy will permit the study of nuclear reactions produced by the bombardment of uranium. It is expected that a considerable advance will be made in the knowledge of the nuclear properties of uranium and the trans-uranic materials.

Application of high-precision current supply to focusing magnet feeds has now been completed by the company for the A.E.R.E. (Harwell) and the C.E.R.N. (Geneva) proton linear accelerators. With the normal variations on the grid supply, an accuracy of $\pm 1\%$ is achieved for 18 kW d.c. supplies ranging from 200 to 1000 A. Load current is remotely controlled to suit the operator's requirements. A control cubicle with easy sliding compartments contains stabilized reference, signal mixing circuits, 'Flux-setter' and controls. The output is supplied to paralleled d.c. generator fields and closed-loop control corrects for inherent variations.



A proton linear accelerator under construction. Two 40 ft liners of the 100 ft long accelerator for the Atomic Energy Research Establishment, Harwell

These two 0.5—50 MeV accelerators each consist of three tanks of approximately circular cross-section, one 20 ft long and two 40 ft long, maintained at a hard vacuum by a pumping equipment. Liners are mounted inside this envelope consisting of similar length tubes made from copper supported on rafts for rigidity into which are fitted hollow cylinders ('drift tubes') mounted along the axis of the inner tank. The proton beam passes along this axis through the drift tubes when the whole tank is excited by radio frequency power at 202.5 Mc/s in pulses of 400 μ sec duration. The fields produced at the gaps between the drift tubes give acceleration, the spacing being so arranged that the particles pass each gap at the correct time relative to the period of r.f. excitation.

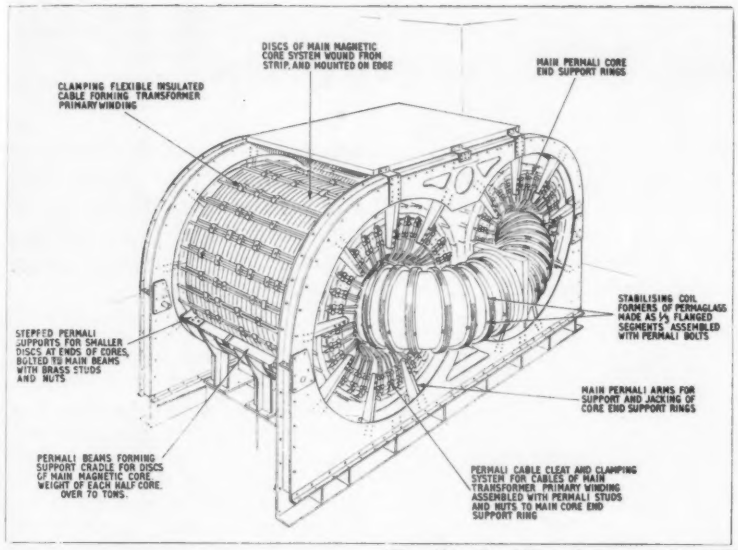
The drift tubes, which are used for beam focusing, are of elaborate construction to very close tolerances with end cheeks accurately formed to precision templates. Electromagnets, cooling tubes and thermistors are built in during assembly prior to vacuum testing.

Structural Insulation in Zeta

Zeta is in principle a large transformer in which the gas to be heated takes the place of the single-turn short-circuited secondary winding. The main primary winding and magnetic core of the apparatus required support and clamping at numerous points where high magnetic flux densities occur during pulsing, with heavy mechanical loadings.

For this reason the main contractors, The Metropolitan-Vickers Electrical Company Limited employed considerable quantities of Permali in the construction of the apparatus. This material is a resin impregnated densified wood laminate chiefly used for high voltage electrical insulation. However, in this instance mechanical strength, resistance to shock loading, and of course freedom from eddy current loss, were the qualities required. In addition, many of the parts were large and complicated in shape. The ease of machining, characteristic of densified wood laminate, was therefore important—coupled with its dimensional stability and the existence of production and machining facilities for large parts.

The main magnetic core system consists of discs wound from transformer iron strip mounted around the two straight portions of the torus.


DISCS OF MAIN MAGNETIC CORE SYSTEM WOUND FROM STRIP, AND MOUNTED ON EDGE
MAIN PERMALI CORE END SUPPORT RINGS
CLAMPING FLEXIBLE INSULATED CABLE FORMING TRANSFORMER PRIMARY WINDING
STABILISING COIL FORMERS OF PERMAGLASS MADE AS 1/3 FLANGED SEGMENTS ASSEMBLED WITH PERMALI BOLTS
STEPPED PERMALI SUPPORTS FOR SMALLER DISCS AT ENDS OF CORES, BOLTED TO MAIN BEAMS WITH BRASS STUDS AND NUTS
MAIN PERMALI ARMS FOR SUPPORT AND JACKING OF CORE END SUPPORT RINGS
PERMALI BEAMS FORMING SUPPORT CRADLE FOR DISCS OF MAIN MAGNETIC CORE. WEIGHT OF EACH HALF CORE OVER 70 TONS.
PERMALI CABLE CLEAT AND CLAMPING SYSTEM FOR CABLES OF MAIN TRANSFORMER PRIMARY WINDING ASSEMBLED WITH PERMALI STUDS AND NUTS TO MAIN CORE END SUPPORT RING

Where Permali and Permaglass were used in ZETA. The approximate size of the assembly is 24 ft wide over main frame, 17 ft overall length of torus and 16 ft overall height. (Drawing by C. & R. Maddox, Gloucester)

These core assemblies rest in cradles formed by densified laminated wood beams. They are also fitted with stepped supports of the same material which carry the smaller discs forming the end of the core. The total weight supported by each cradle is over 70 tons. The core assemblies are retained in vertical alignment by means of end clamp rings of densified laminated wood some 10 ft dia. These rings are supported from main steel end frames by means of Permali bracing arms which are fitted with adjusting and jacking screws, enabling the position of the core assemblies to be accurately adjusted and ensuring even support.

The main primary winding of the transformer consists of insulated cables wound around the core, in the same way as on a ring-type transformer, and passing through the bores which they share with the torus. Where these cables pass across the end rings they are clamped in position by means of cleat assemblies of densified laminated wood, which is also used for studs, nuts and additional members in other parts of the structure.

In addition to this material, Permali Limited supplied the polyester resin fibreglass coil formers which support and position the windings on the torus itself. These supply the stabilizing field used to prevent "wriggling" of the hot gas column during operation. Each coil former consists of three segments connected by flanges to facilitate assembly in the restricted space available.

Scaffolding at Hinkley Point

To ensure a solid foundation for the cooling water intakes of the Hinkley Point, Somerset, atomic power station, it was necessary to erect an offshore drilling tower so that rock samples could be taken from 50 ft below the sea bed.

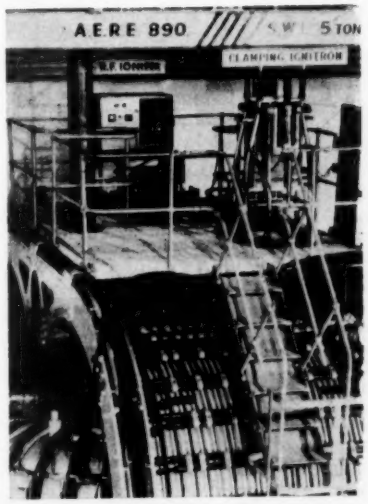
The tower used for this work was constructed from 2 in. dia steel scaffold tubing and spring steel fittings, supplied by the Bristol branch of Mills Scaffold Company Limited. It was erected on site, slung between two pontoons, towed to the drilling position 2000 ft offshore and then sunk in a mean depth of 40 ft of water, the tower at high tide standing 30 ft above sea level. The structure was stabilized by attaching it with guy ropes to concrete blocks resting on the sea bed. Proof of the structure's strength can be given by the fact that it withstood frequent gales and heavy seas.

Construction of Hinkley Point, the largest atomic power station in the world, is estimated to be completed in 1962. It will have an electrical output of 500 MW, which is almost seven times that of Calder Hall A.

The main civil engineering and building contractors are Taylor Woodrow Construction Limited, members of the English Electric/Babcock & Wilcox/Taylor Woodrow Group who are responsible for the design and construction of the station to the order of the Central Electricity Generating Board.

Argon for Dounreay

The use of argon to provide an inert atmosphere plays an essential part in the United Kingdom Atomic Energy Authority's project at Dounreay. The gas employed for this purpose must reach exceptional standards of purity since even the smallest contamination by air will render it useless. In order to avoid unnecessary waste of this valuable gas, the Authority has awarded a contract to British Oxygen Engineering Limited for the installation of a special plant which will remove all traces of air from the gas and return it to its original state of high purity. Basically, the process is one of injecting hydrogen into the impure gas to act as a reducing agent by removing oxygen in the form of water, and of subsequent low temperature distillation for nitrogen removal. Refrigeration for the process is provided by the use of liquid oxygen, and the contract includes the provision of two small liquid oxygen plants and a liquid oxygen storage vessel.



ZETA'S IONISER.—ZETA uses a modified Radyne C.21 electronic heater made by Radio Heaters Limited, to provide the radio frequency voltage necessary initially to ionize heavy hydrogen gas. Once the gas is ionized it immediately forms itself into an electrically conducting ring which acts as a short circuit secondary winding on a special form of large transformer

Metal Polishing Developments

Last month the author compared and contrasted the old with the new in polishing techniques, outlined improvements in the use of mops, bobs and belts, and dealt with the technical and economic advantages and limitations of the new 'self-polishing' plating processes. In conclusion this month he similarly considers vapour-blast smoothing, barrel finishing, and chemical and electrolytic buffing treatments

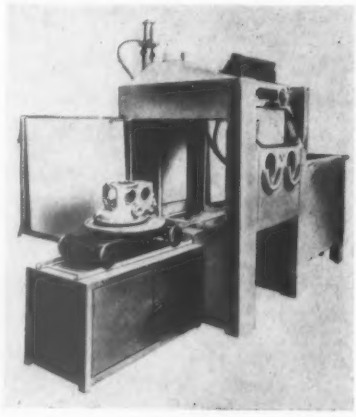
By D. J. FISHLOCK

Wet-blasting processes

Blast-cleaning, using abrasive in compressed air, dates back to the 19th century. Sand was the usual abrasive then, but has more recently been replaced by steel grit or shot in order to eliminate the silicosis hazard. Most dry blast cleaning is strictly utilitarian and yields a thoroughly cleansed but decidedly rough finish, chiefly in preparation for painting, galvanizing, etc. There is a limited use for small, low-pressure units which when used with a fine abrasive can produce a fine, mat or frosted finish.

The advent of wet blasting, however, under various commercial soubriquets such as vapour blast, 'Hydro-blast', 'Aqua-flow', etc., brings blast finishing into line as a competitive metal polishing process. Although again not new in principle, wet-blasting gained prominence during and after the war, and has now been developed to the stage where, using a single abrasive mixture, a comparatively rough surface can be sometimes turned out suitable for bright nickel plating—surely the criterion of a successful polishing system. The process is simplicity itself, since it differs in operation from shot-blasting only insofar as the abrasive is suspended in a water-stream.

The equipment is similar to a shot-blast cabinet, comprising a totally enclosed cabinet provided with a wide viewing screen and arm-holes to which rubber gloves are attached. The plant uses a suspension of abrasive in water, usually of some 40% by volume. This clearly requires some ingenuity both to maintain the suspension and to circulate it via a blasting nozzle, and a variety of systems have been devised; they include a gravity feed into a compressed air stream, a Mono pump or plunger pump feed also into an air stream, and most recently a high-pressure centrifugal pump feed which can be used with or without air and at two different speeds to produce various effects. A carefully designed blasting gun, provided with a special nozzle, effectively completes the plant.



Abrasive Developments Limited

Fig. 10. 48 in. x 53 in. manually-operated unit. Vapour blast

Abrasive Developments Limited

Fig. 11. An automatic vapour blast unit for the treatment of motor car push rods. The two types of blasting operation, i.e. with and without air acceleration, can be successively performed in this machine to produce a very high finish

Differentiation must be made here between the effects produced with and without compressed air acceleration. The more commonly encountered process uses air at 80–100 psi and is usually known by the terms mentioned above. In this case the water acts largely as a medium in which the abrasive is conveyed. When the slurry emerges at high velocity from the gun the two components become separated, the water travelling more slowly. Sufficient liquid still remains with each abrasive particle, however, to damp its cutting action and ensure a markedly different finish to a dry-blasted one. In the absence of compressed air, but at pumping pressures of some 50 psi or higher (e.g. Aqua-blasting) the abrasive particles retain a substantial liquid envelope which much more effectively suppresses the abraiding action. These two processes are complementary and can be used successively to produce a very high finish from a comparatively coarse one.

The abrasives used are of interest, and usually comprise synthetic forms such as silicon carbide (rounded particles) and aluminium oxide; in the U.S.A. the natural rock novaculite (SiO_2) is often used. Organic materials such as crushed plastics, wheat-husks, walnut-shells and flour are incorporated for the finest finishes, and are available down to 5000 mesh. The abrasives are suspended in water which is usually warmed for comfort and which includes corrosion inhibitors to prevent tarnishing of the very clean and therefore active treated surfaces.

There are, therefore, a number of variables which can be controlled to yield a given effect, these including the size, concentration and nature of the abrasive, the pumping

and/or air pressure, the nozzle size, the angle of the nozzle to the work, and its distance from it. With a trained operator and using a dual-speed pump the variables can be effectively reduced to two—pump speed and air pressure. Thus polishing can be achieved with a single abrasive mixture in four stages—roughing, smoothing, finishing and satin polishing.

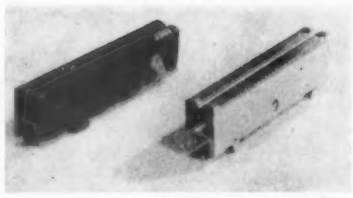
Examples of the application of this process are many and include parts of complex contour all faces of which cannot be wheel or belt polished. Hard metals such as steel and the heat-resisting alloys are especially amenable and give the highest final finish (Figs. 12 and 13); for instance, the final stage for steel uses a 60 mesh abrasive, without air, in a 50/50 suspension at a pump delivery pressure of 80–100 psi. Finishes as low as 3–4 micro-inches are obtainable which can be directly bright nickel/chromed to a good finish. The treatment of dies for die-casting is a very important application; here it can impart a finish which produces a casting needing virtually no polishing other than cleaning up before plating.

A further development of this versatile technique facilitates the treatment of large areas of metal—in particular sheet or strip material or large articles without cavities. In such cases a centrifugal or Pelton wheel type of impeller is used in place of compressed air. The centrifugal pump delivers the slurry to the fast rotating impeller which discharges it, at a higher velocity than does air-acceleration, uniformly over a large area. This avoids the otherwise very high air consumption, greatly speeds up processing, and with thin sheet metal prevents the buckling otherwise found unavoidable when sheet is blasted in narrow strips across its width.

Barrel polishing

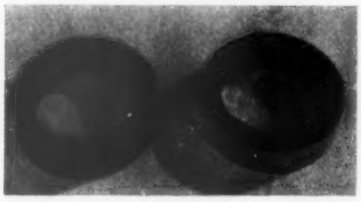
Barrel polishing is a useful and extremely economical method of producing a uniform finish on reasonably small articles. It is fraught with limitations, chiefly appertaining to the size, shape and contour of the work, and to the fact that it is still largely an empirical technique, but where it is applicable the results can be most satisfying.

The principle behind the process is the abrading action engendered by work tumbling against itself and through a semi-fluid medium. The



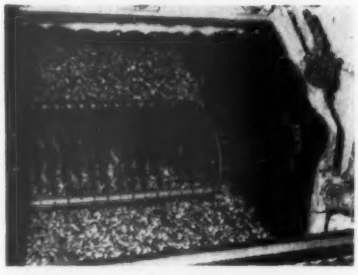
Abrasive Developments Limited

Fig. 12. Electric razor head section, showing finish before and after this component was treated with 180 vapour blast



Abrasive Developments Limited

Fig. 13. Internal cam from pump unit, treated with 60 Aqua on internal and external surface. Finest possible finish obtainable



Roto-Finish Limited

Fig. 14. Roto-Finish stationary fixture machine showing wide apertured door and slotted guide rail for rack. These features, now standard on all Roto-Finish stationary fixture machines, facilitate loading and unloading of loaded rack. The guide rail is removable, thus the machine can be used for free barrelling or fixture work

continual abrasion in a slowly turning barrel effectively scours away the surface layers, together with asperities and burs, to produce a level surface, while by the judicious use of a series of barrels containing different media, the work can be brought to a state of high burnish, although not to a mirror finish.

A large variety of barrels have been designed for the various stages, but basically these may be considered as falling into one of the following three categories:

(a) long, small diameter, horizontal barrel
(b) short, large diameter, horizontal barrel
(c) horizontal, obliquely mounted barrel.

Barrel speeds must be kept low—16 to 60 rpm—since the work must tumble back through the media and not be carried around by centrifugal force in a spinning barrel. For this reason polygonal barrels have proved more satisfactory than round-walled ones.

For the scouring stage, abrasives such as emery, lime and pumice are used, usually in a liquid medium such as oil or water. Dry scouring may be carried out, but the resultant finish for a given grade of abrasive will be coarser. Various additions may be made to an aqueous medium, principally alkalis, inhibitors and wetting agents.

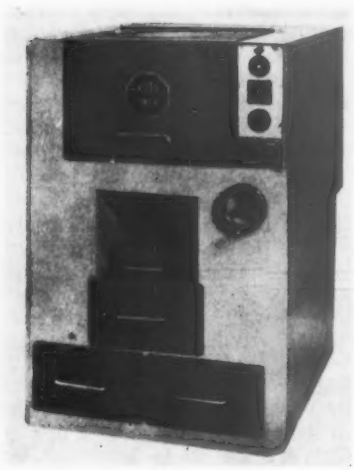
Again, during burnishing a variety of materials are used, chief of which are polished, hardened steel balls, pebbles and chips, and leather cuttings. The ratio of work to polishing media is of paramount importance and for the most part must be ascertained individually for a given article and installation. Basically, seven variables require attention, viz:

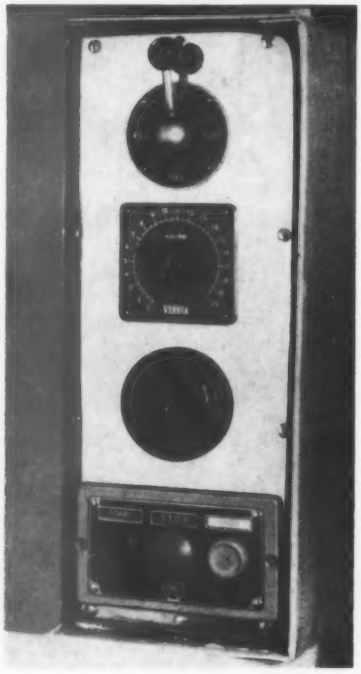
(1) type and size of chip
(2) type of compound
(3) level of the mass in the barrel
(4) ratio of chips to components
(5) water level in the barrel
(6) speed of rotation
(7) time.

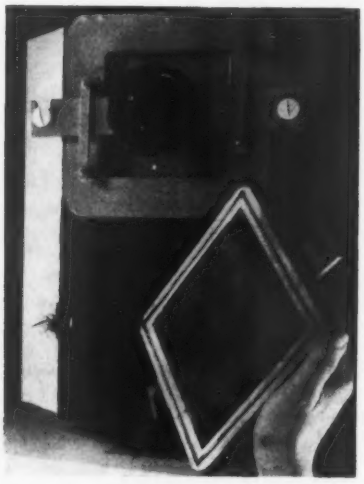
In the last few years much study has been devoted to the mechanism of barrel finishing, and to evolving fool-proof equipment and techniques for processing. The Roto-finish precision barrelling process is an excellent illustration. For this, a wide range of versatile yet aesthetically acceptable and compact plant has been evolved with which a highly efficient, clean and dust-free barrelling shop can be laid out. An equally meticulous approach has been in the evolution of suitable grinding media, and three constituents only need be added to the work-water, the cutting chip (of which there are 17 sizes in a variety of materials), and a proprietary chemical mixture in powder form; the latter is selected according to whether the metal is ferrous or otherwise, and whether it is desired to enhance the cutting action of the chip, e.g. by incorporating an abrasive, or suppress this action, e.g. by incorporating lubricants or substances which will form a coating on the chips. For final stages, chemicals which will brighten the metal are needed, while rust-solvent and rust-inhibiting materials constitute other additions.

The basic item of plant is a rubber-lined octagonal barrel fitted

with a sealed quick-release door. Such features as a time switch and a variable speed drive are fitted when required, Fig. 15. Auxiliary gear includes hoppers to facilitate loading and a magnetic separator for the speedy separation of ferrous parts from the abrasives, Figs. 16 and 17. Barrels are available for loads up to 500 lb, in several compartments if needed. From this basis a variety of special-purpose machines has been devised, including a fully automatic model which can be built into an automatic production line and can be controlled by card or punched-tape for such variables as chip size and compound. Another very promising development has grown out of the now well-established practice of securing the larger types of article







Roto-Finish Limited

Fig. 15. The Midget, a compact and versatile barrelling machine, showing also (right) the repeat processing timer and variable speed control and also the quick-release but effectively sealed door

(usually over 1 lb in weight) in a static jig and tumbling the abrading media past it. This is the Roto-Ram invention by means of which very long articles—currently up to 25 ft in length—are finished by oscillating them by hydraulic power at some 35 cycles/min in a long trough containing the media. The finish produced in this way is not high, but the surface markings which have been found to originate fatigue-cracks in highly stressed components, such as aeroplane spar-booms, are rapidly eliminated. It is also of interest to record that the Volkswagen works are using a single stage Roto-finish barrelling operation to prepare steel bumper over-riders for plating in 2½ hr, thereby reducing the 36 skilled polishers to 10 (largely unskilled) men.

Before leaving barrel finishing there is an important American development known as Gyrofinishing, a hybrid blast-cum-barrel treatment, which promises soon to play an important role in mass-production polishing. This overcomes the fact that polishing barrels cannot be run at speeds much greater than 30 rpm by using a vertical barrel containing an abrasive slurry which is rotated at high speed while the work is attached to a counter-rotating central jig. Herein lies the promise of reducing the number of hours now needed for barrelling almost to the same number of minutes, while producing surprisingly good finishes on complex contours.

Solution polishing

An inevitable concomitant of most, probably all, mechanical methods of surface finishing is interference with the crystal structure of the surface layers. This is most noticeable in mop polishing where the early stages scrape and tear the metal into a reasonably level surface, and the later stages, using very fine lubricated abrasives at high velocity, tend to raise the surface crystals to a temperature at which they are plastic; these are then pushed and flowed into a smooth finish. Beilby was first to point out the important differences in physical properties which could be expected in this region, and lends his name to the now familiar 'skin' of distorted amorphous metal some 20 to 40 Å deep which is characteristic of polished metal. The Beilby layer is a most complex and indeterminate region resembling a hard, enamel layer, but composed of shattered crystallites, oxide fragments and abrasive particles—'a sort of porridge', as one scientist recently put it.

The purpose of the etching treatments used both in metallography and in electroplating practice is to remove this distorted layer, in the one case to allow the true crystal structure to be examined, and in the other to eliminate a physically rather unsound layer which could cause faulty adhesion of an electroplate. Experiments by Jacquet in the 1930s evolved a new technique for metallographic preparations which completely shifted the Beilby layer, yet left the metal even more highly polished than before. Known as electropolishing this, together with the more recent refinement of chemical polishing, is now an established production process.

The basic principles of electro- and chemical polishing are similar

Fig. 16. Roto-Finish Magnetic Separator. 6 in. single drum underfeed magnetic separator

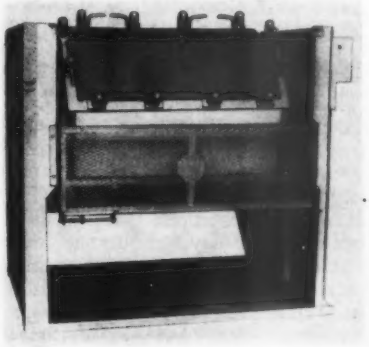


Fig. 18. Machine with safety guard lowered to show special fixture door, which occupies two adjacent flats

and comprise the preferential electrolytic dissolution of surface asperities, leading to an overall levelling of the metal. In the one case an applied current is used with the job as the anode, and in the other the galvanic currents generated within the solution are utilised. The mechanism is probably closely concerned with the formation of a viscous film in contact with the anode which is of high resistance, but thinner in the region of asperities. More current thus reaches such regions and they dissolve faster.

Solution polishing is indisputably the most elegant of all polishing processes, since it virtually dispenses with machinery and its associated noise and dirt. Once believed to be the Philosopher's Stone of polishing practice, through the medium of which any metal of any surface

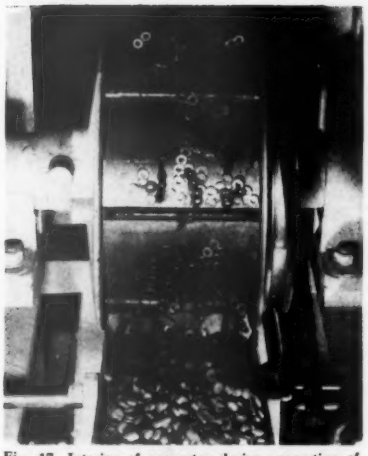


Fig. 17. Interior of separator during separation of washers from Roto-Finish white grinding chips

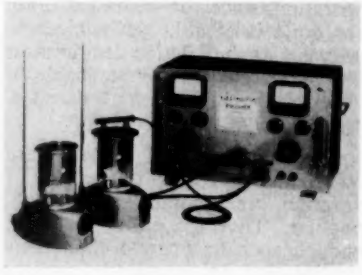
condition could (eventually) be highly polished, this visionary view has undergone considerable attenuation and certain grave limitations of this technique are now largely appreciated. Foremost is the one relating to economics; electropolishing requires both relatively concentrated and therefore costly

Fig. 19. Installation of eight different types of Roto-Finish machines at the works of the Dunlop Rim and Wheel Company Limited, Foleshill, Coventry. These machines are used for deburring and radiusing component parts of Dunlop motor car and aircraft disc brakes and also for component parts of aircraft equipment produced by this company

solutions and heavy direct current supplies, while the first requirement is also characteristic of chemical polishing. Again, the quality of metal is vital, since neither heterogeneous nor heavily scored metal can be treated successfully. A fine-grained, single-constituent metal, free from joins, inserts, and inclusions, is essential for the best results. Even this, however, cannot always give a finish quite as good as a perfectly mechanically buffed one.

On the credit side, though, the results of either technique on a limited number of metals and alloys is extremely encouraging. In combination with mechanical polishing in the early stages, metals notoriously difficult to high polishing, such as stainless steel and aluminium, can be very quickly 'electro-buffed' to a very good finish with no possibility of 'burning', i.e. overheating the metal. Particularly if the surface is irregular, broken or engraved, the slightly lower polishing standard is undetectable, and indeed in the case of 99·99% aluminium and, more recently, the rather harder 1% magnesium alloy, the finish surpasses that given by mechanical polishing; hence its use for high-quality reflectors.

Solution polishing requires a shop and layout similar to an electroplating plant, with chemically resistant vats equipped with heaters, agitators, fume-exhausters, etc. The solutions with a few exceptions are concentrated acid mixtures which require analytical control for consistent results. Electropolishing also requires a rectifier of substantial output at (usually) a rather higher voltage than is needed by plating. On a small scale, however, it is possible to polish chemically small basket loads or single jigs of work



Nash & Thompson Limited

Fig. 20. A laboratory electropolishing unit for preparing samples for metallographic examinations

in a self-contained, entirely plastic unit. This completely exhausts and neutralizes the copious fumes evolved and deals with the effluent entirely automatically.

Dealing with some of the situations which solution polishing can confidently handle, we find that the industrial electropolishing of stainless steel, aluminium and some copper alloys is now well established. Electro-deposits too, notably of nickel and silver, can be treated and, in fact, admirably fulfil the requirements outlined above concerning the quality of the metal. There are two main processes for treating aluminium, the Brytal process being the most used in Britain. This uses a solution of 15% sodium carbonate and 5% trisodium phosphate at 80°

to 82° C. The cleaned work is first immersed for 10 to 30 sec and allowed to etch, after which it is made anodic at 12 volts for 5 to 15 min. After a swill in an acid desmutting bath it can be anodized and then dyed if required. Stainless steel is usually treated in a hot sulphuric/phosphoric acid mixture at 150 to 300 amp/sq ft and 6 to 14 volts for several minutes, this dissolving about 0·0001 in. of metal per minute. Excellent results are obtainable on work which would be very laborious and even impracticable to polish otherwise, and the metal remains undistorted and unstressed. The electropolishing of nickel electro-deposits, notwithstanding some excellent results in 70% H_2SO_4 at 250 amp/sq ft, is not widely used because of the risk of dissolving too much nickel; silver, though, can be transferred from the plating vat directly to an electropolishing solution containing the same constituents, and the redissolved silver directly reclaimed by plating it on to silver cathodes at some 5 volts. Electropolishing is at this stage essentially a manual operation, since the treatment times are quite brief although subject to increases as the solution deteriorates; barrel treatment is impracticable in view of the high current densities used.

Chemical polishes, which are essentially acid dips of very brief duration, are becoming increasingly popular. They are easier to install and cheaper to operate than their electrolytic counterparts, mainly because of the eliminated external power supply. For instance, solutions are available both for aluminium and for copper base alloys while a useful process for steel has recently emerged. The latter utilizes a quite dilute solution, known as Marshall's solution after the inventor, comprising:

Oxalic acid ...	...	25 gm/litre
Hydrogen peroxide	12	,,
Sulphuric acid	0·1	,,

This usually needs from 1 to 10 min used cold and can effect a considerable amount of smoothing with little loss of metal. Unlike most chemical polishing baths there is no fuming, and the solution works well in a barrel.

The number of solutions proposed for treating aluminium is legion, and they range from highly viscous alkaline solutions through a variety of strong acidic baths to a very dilute, acid-formula. This latter, one of the most successful since it is relatively cheap to prepare and not adversely affected by dragged-in water like many of the others, is now widely used on the Continent for the treatment of aluminium of good surface quality. This is then anodized and used in place of chromium plating for motor car trim in particular, combining an equal attractiveness with higher durability in many cases. The solution used is of 13% nitric acid, 16% ammonium bifluoride and 0·02% lead nitrate, treatment being for 15 to 30 sec at 50° to 80° C. Super-purity (99·99%) aluminium and its magnesium alloys are the most suitable. The metal is dissolved rapidly and providing the operating conditions are correct, very good finishes can be obtained for relatively coarse surfaces without pre-polishing.

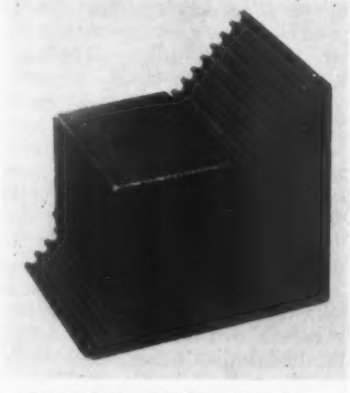
A more concentrated type of solution is one based on a nitric/phosphoric acid mixture (e.g. 75% H_3PO_4, 5% HNO_3, 20% H_2O). The aluminium must be clean and dry when immersed in the solution at 100° C or thereabouts. Some 2 to 5 min treatment with slight agitation, followed by an acid desmut completes the treatment. This process also gives very good results but does require an efficient fume exhaust; it can, however, be usefully operated in a totally enclosed fume hood.

Copper base alloys can also be chemically polished—at best to give finishes which can be bright nickeled directly. Bright dips, based on nitric acid moderated by the addition of sulphuric acid, have been used for many years, but the modern solutions give an incomparably smoother, more reflective surface. A whole range of solutions is based on three constituents, phosphoric, nitric and acetic acids in varying proportions, and sometimes with additives, and used at elevated temperatures for a few minutes. Collectively they cover copper, brasses, bronzes, cupro-nickels and nickel silver. Lead (and soldered joints) in the materials must be avoided and good fume extraction is essential.

Serrated Step Blocks for Positive Clamping

An important aid to clamping parts for machining is now available in the form of Crocodile adjustable step blocks. The blocks are made in four different heights, all of them with meshing serrations so that all sizes are fully interchangeable. The interlocking stepped profile gives optimum security as compared with flat steps and guarantees positive clamping in any position. Crocodiles, a Swiss product made of case-hardened tempered steel to a tolerance of ·004 in. are supplied from stock in the United Kingdom by Insley Industrial Supply Company Limited, 21/22 Poland Street, London W1. Special aluminium trays provide a neat container when the blocks are not in use.

MACHINE LOADING WITH HAND-HYDRAULIC PLATFORM LIFT.—Press tools, dies, bolster plates and bin and post type pallets of up to 300 lb can be lifted to 4½ ft and transported on the Lodematic Mk. I hand-hydraulic platform lift. The platform which can be halted at any intermediate height is powered by double-acting hand-hydraulic pump, giving a reasonable speed of lift with moderate effort. The platform lowers by gravity under manual valve control. For speedier operation the Lodematic, manufactured by Lodematic Limited, Clitheroe, Lancs., can be electrically powered and other models with manually controlled or load actuated platforms are available with up to 12 ft lift



Swiss-made Crocodile adjustable step block

Infra-red Radiation of Hot Strip Controls Its Width

A system for controlling the width of material issuing from a continuous hot strip mill by utilizing the natural radiation of infra-red rays from the strip itself was initiated by the British Iron and Steel Research Association. Now after further development work Evershed and Vignoles Limited, Acton Lane Works, Chiswick, London W4, have installed a width measuring gauge working on this principle at the Steel Company of Wales. Basically the width gauge is a servo-driven optical arrangement for monitoring the deviations in width of continuous hot strip and is sufficiently sensitive to respond to material that has cooled to a very dull red.

Width measuring gauge controlling the material issuing from a continuous hot strip mill at the Steel Company of Wales by radiation

Two edge followers are mounted upon a traverse which straddles the mill a few feet above the run of strip, and are motorized so that the two may be spaced apart to a distance equal to the nominal width of strip being produced. Each one tracks the individual motions of the edges, the combined readings being summated electrically to give a signal proportional to the deviation in total width.

The method of detecting and tracing the change in edge position reduces to the minimum variations that may arise in signal strength due to fluctuations in the rolling temperature. Radiation from the surface of the strip is projected through a lens and prism on two photocells, placed side by side. One of the cells receives a constant amount of energy from a section of strip inboard of the edge, whilst the other is activated by the edge itself. Movement of the edge increases or decreases the radiation upon this cell dependent upon the direction in which the strip moves. A shutter is driven across the face of the other photocell reducing the energy upon it to a value equal to that obtained by its neighbour. This system of balancing radiation ensures freedom from temperature effects and compensates for changes in the cell characteristic due to ageing.

Each follower is self-contained inasmuch as it consists of an optical and photo-electric sensing device which presents a "chopped" signal to a built-in 50 cycle amplifier, the output of which drives the shutter mechanism by means of a small a.c. servo motor. Adjustable damping is provided by means of tacho-feedback derived from a small generator attached to the end of the motor. The unit operates on a 50 V single phase supply.

A typical layout as applicable to a wide strip mill is shown in Fig. 1. It will be seen that the followers are mounted on a special gantry above a foot bridge and traversed by two motor driven lead screws enclosed in an oil filled trunk which forms the follower slideways. The motor may be seen at the left-hand end, and at the right is a shaft extension which is coupled by bevel gearing to an indicator for the setting of nominal width. This indicator is purely a mechanical arrangement of two pointers and dials and is calibrated to read over the whole range of widths to the nearest $\frac{1}{32}$ in. The small panel mounting houses a roll chart recorder which is used for the continuous recording of nominal width, and deviation up to ± 3 in. One remote indicator, also calibrated to ± 3 in., is shown mounted flush in the top of the finishing operator's control desk. Any number of

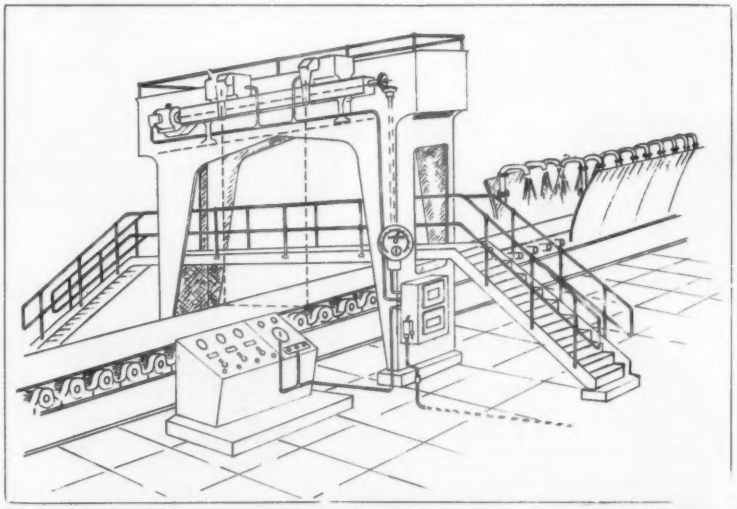
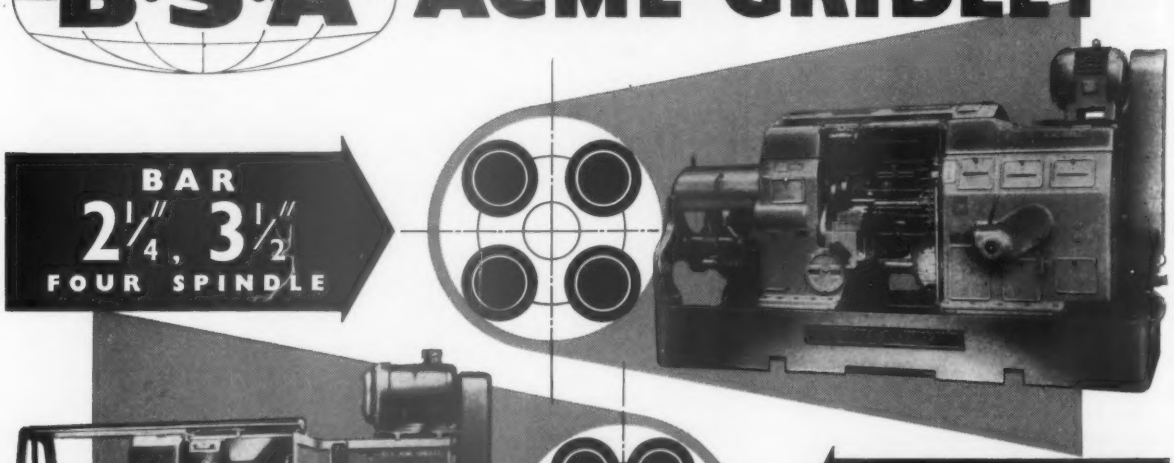
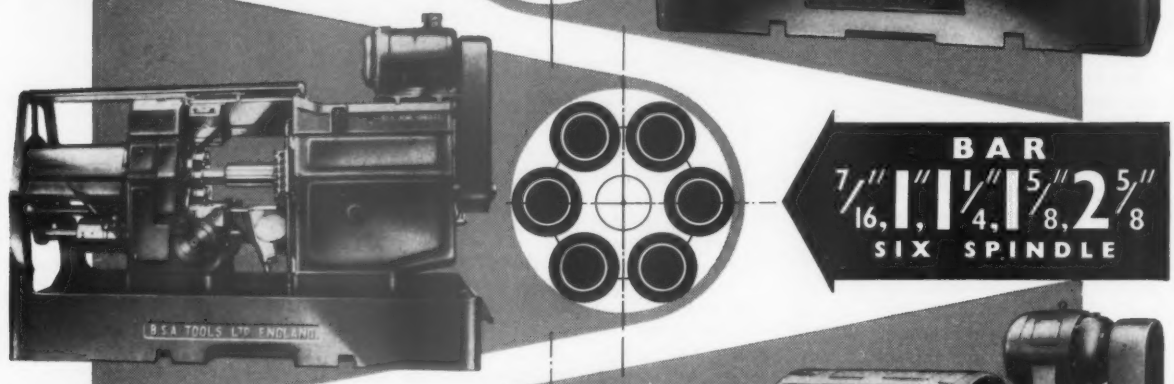


Fig. 1. Simplified layout shows the two edge followers mounted on a special gantry above the foot bridge, the operator's control desk and dial indicator

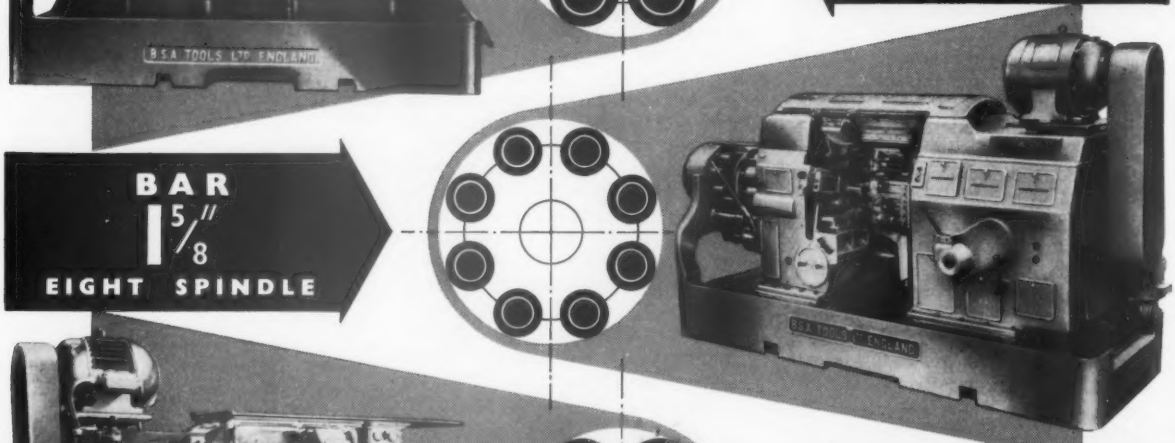
B·S·A ACME-GRIDLEY



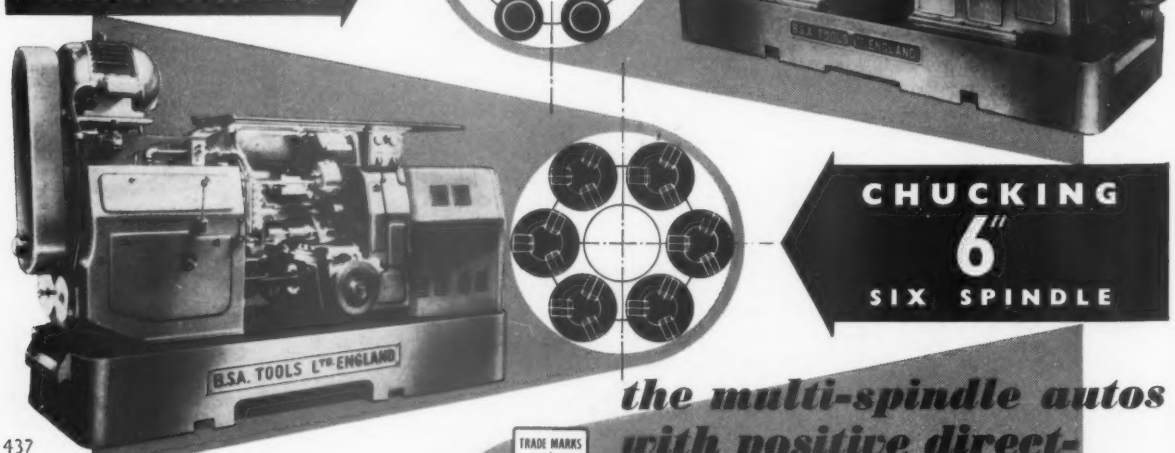
BAR
2¼″, 3½″
FOUR SPINDLE



BAR
7/16″, 1″, 1¼″, 1⅝″, 2⅝″
SIX SPINDLE



BAR
1⅝″
EIGHT SPINDLE



CHUCKING
6″
SIX SPINDLE

437

the multi-spindle autos with positive direct-action quick-change cam control

TRADE MARKS
B·S·A TOOLS GROUP

MAKERS
B.S.A. TOOLS LTD · BIRMINGHAM · 33
ENGLAND

SOLE AGENTS GT BRITAIN BURTON GRIFFITHS & CO. LTD. · KITTS GREEN · BIRMINGHAM · STECHFORD 307

indicators may be used as the system employs conventional milliammeters wired in series.

Cooling of the apparatus mounted above the mill is necessary and for this purpose a supply of water must be provided.

Repetitive Hydrostatic Chucking Concentricity to ±.00008 in.

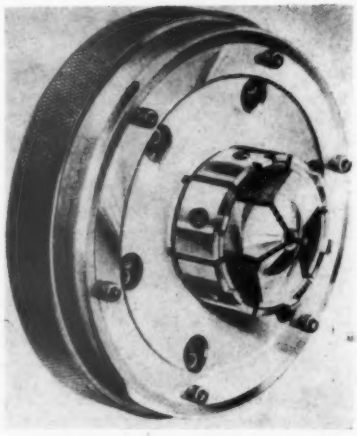
Successful trials in their own workshops have prompted Integral Limited, Birmingham Road, Wolverhampton to market the Everac diaphragm-type hydrostatic chuck which is entirely self-contained. The chuck is primarily intended for precision finishing of previously machined components and small die castings which have an accurate chucking diameter. Depending on the degree of accuracy desired the chucking size of components should be maintained to a tolerance of ·0002 to ·003 in. to obtain the repetitive concentricity of ±·00008 in. which the makers claim for the chuck.

The principle of operation may be seen from reference to Fig. 1. The chuck has two diaphragms, a main diaphragm which carries the split chucking ring on its external face and an inner diaphragm which forms one wall of an internal chamber filled with hydraulic fluid. The fluid chamber communicates with a small-diameter cylinder containing a sliding piston which may be depressed by external means. Operation of the piston causes an increase in fluid pressure which acts on the inner diaphragm, deflecting it outwards. A central boss projecting from the inner diaphragm acts on the outer diaphragm causing it also to distort so that there is a small radial outward movement of the six segments of the chucking ring and of any jaw pads attached to them.

On release of the piston the two diaphragms tend to resume the unstrained position under their own elasticity and the jaw pads grip any object of suitable size placed between them.

The strength of grip of the chuck is thus independent of any externally applied force and depends entirely upon the elasticity of the main diaphragm and the amount by which the chuck jaws are held open by the workpiece. The grip can be regulated to suit any component by adjusting the internal diameter of the jaw pads and thus the amount by which the jaws are held open.

One advantage of hydrostatic operation is the absence of fluid pressure except when the jaws are actually being held open by a load on the release piston. There is therefore no possibility of the jaws accidentally releasing the workpiece. Another feature is the high mechanical advantage, a ratio of load on piston to load on chuck jaws of 140 to 1 being easily obtainable. Due to the light load required extremely simple methods of operating the piston can be adopted. In its simplest form the chuck has a single piston, which can be depressed by finger pressure, located on the periphery of the chuck; another version, shown in our illustration has three pistons operated by a knurled cam ring around the chuck. Alternatively, the piston may be positioned axially at the rear end of the chuck and depressed by a spindle push rod operated either manually or by remote control.



Everac hydrostatic chuck

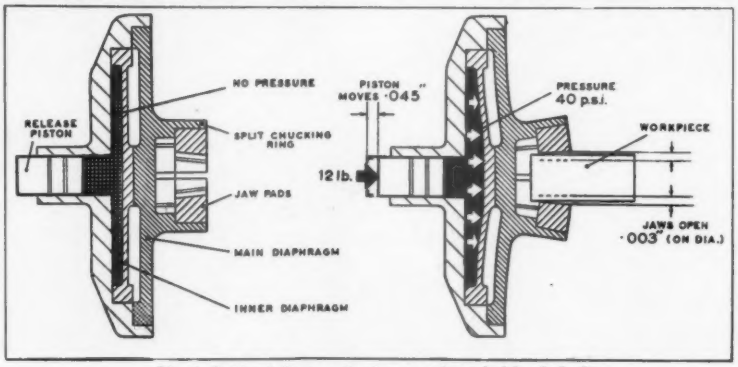
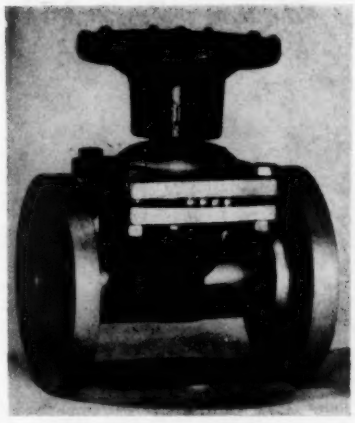


Fig. 1. Sectional diagram showing operating principle of chuck

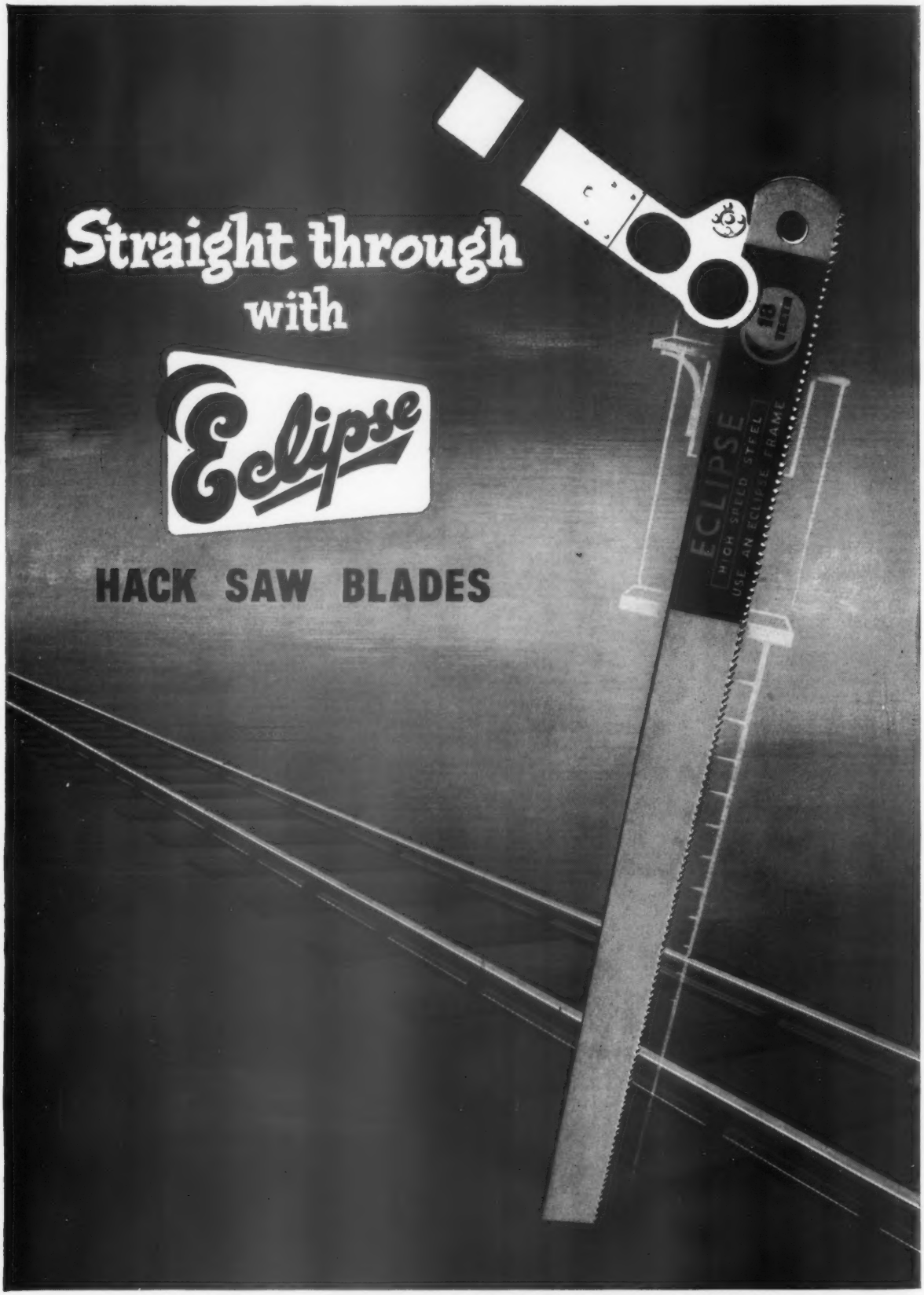


GLANDLESS STOP VALVE.—By using a rubber diaphragm to seal off the moving parts of the valve from the fluid under control no packing glands are required in the Meynell Rayon-Patent stop valve. The rubber fits in a formed chamber to ensure a perfect seal when the valve is closed and presents an unrestricted fluid passage when opened. It is produced with either non-ferrous or cast iron bodies in sizes from ¼ to 6 in. dia. by Meynell and Sons, Montrose Street, Wolverhamtpon for non shocking pressures from 65 to 220 psi according to size

Low Voltage Supply Direct from the Power Point

A compact transformer plug which may be plugged in to a 3-pin socket, direct to the existing mains supply to step down the current from 240 to 25 V should ensure complete safety to operatives working with long lead electrical appliances.

The Dohm Electran transformer plug constructed and cased in hard oil resistant rubber is marketed by the Dohm Group of 167 Victoria Street, London SW1. It has been designed to avoid the expense of installing low voltage wiring systems where low voltage inspection lamps, soldering irons and machine tools are used.



'Eclipse' hacksaw blades and other tools are made by James Neill & Co. (Sheffield) Ltd. and are obtainable from all tool distributors

UH25

books

Management for Engineers. By Roger C. Heimer. New York, 1958; McGraw-Hill Book Company Inc. London; McGraw-Hill Publishing Company Limited. 52/6 net (by post 54/3). 453 pp. 6×9 in.

Business the world over has common factors, though there are laws and practices special to particular countries. This book is an American text and deals with management in the American framework. So far from being a disadvantage this makes it rather the more interesting to the British reader, for the most of the book is about the way Americans treat common problems and a little of it is informative about special American circumstances. It is therefore a useful text in a number of ways. It begins by defining the professional engineer and discussing his status, training and qualifications and goes on to consider the various forms taken by the business organization, explains the flow of money in the business enterprise, the nature of profits, how costs are ascertained, the use of investment, power and light, insurance, depreciation, inventory, standards, labour and equipment costing, budgets, communications and co-ordination, and concludes with the circumstances and methods of reaching decisions and discusses some of the situations in which they arise.

Careers Encyclopaedia. Edited by G. H. Chaffe and P. J. Edmonds. London, 1958; Cleaver-Hume Press Limited. 15/- net (by post 16/4). 672 pp. $5\frac{3}{8}\times8\frac{1}{2}$ in.

The question of careers is a more than usual preoccupation these days but few people are inclined to collect or read the mass of available literature. One great advantage of this encyclopaedia is that it presents so much in one pair of covers and at such a reasonable price (the second edition is ten shillings cheaper than the first). Two equally important advantages are its conciseness with adequacy and the high quality of the advice it offers. It describes the work of those engaged in the various professions and occupations and explains the training and qualifications required and the remuneration to be expected.

Each section ends with a bibliography of books and publications to consult for further information.

Many will find the prefatory note by Mr. Gavin Brown, on making a choice of a career, particularly helpful —it disposes of one or two traditional notions and will bring a sigh of relief to many a youngster, and many a parent too. Appendices give particulars of the G.C.E. and requirements for admission to the universities, scholarships, deferment of call-up, lists of occupations of special interest to women and of correspondence colleges.

Kempe's Engineer's Year Book for 1958. Edited by C. E. Prokter under the direction of B. W. Pendred. London, 1958; Morgan Brothers (Publishers) Limited. Two volumes in case 82/6 net (by post 85/-). 2740 pp. $4\frac{3}{4}\times7$ in.

The 63rd edition of Kempe's shows the thorough revision which maintains it in popularity as an authoritative as well as a comprehensive work of reference. Among the larger additions and revisions may be noted the newer welding processes, spark machining, water treatment, protective coatings for steel, diecasting, abrasive materials, ceramic tools, buoyage, rail fastenings, supersonic flight, oscilloscopes, air flow—and these are not by any means all. The whole work covers all the branches of engineering—civil, mechanical, electrical, water, railway, electronic, gas, steam, mining, highway and public health; also the scientific fundamentals—measurement, mathematics, mechanics, heat, optics, acoustics, vibration, thermodynamics, hydraulics, theory of structures etc; and a host of special interests like materials, foundrywork, welding, cranes, harbours and docks, lubrication, gas turbines, atomic power, naval architecture, refrigeration, heating and ventilating, surveying, bridges—and a whole lot more, too much to attempt to enumerate from the several thousands of compactly printed pages.

New Standards

Diamond dies for wire drawing (B.S. 2946:1958). Price 4/-.

With the inclusion of requirements for both reinforced and non-reinforced dies, this revised edition of B.S. 2946 supersedes the existing standards for these products (B.S. 1393 and B.S. 1168 respectively).

The specification contains clauses on quality of die stones, bore of the die, mounting, casing, size, assembly of die and marking. One of four appendices contains a summary of the information recommended to be supplied with an enquiry or order.

Glossary of terms relating to powders (B.S. 2955:1958). Price 4/6.

Following a definition of powder (arbitrarily decided upon as "discrete particles of dry material of size less than 1000 microns maximum dimension") the standard enlarges on the various terms associated with powders under the following headings: types of powder, particle size, particle shape, powder properties, and powder processing.

The two appendices to the standard deal with 'Mean diameters of particulate systems' and 'Calculation of Stoke's diameter' respectively.

Dimensions of 3-phase electric motors with ventilated enclosures (B.S. 2960:1958). Price 6/-.

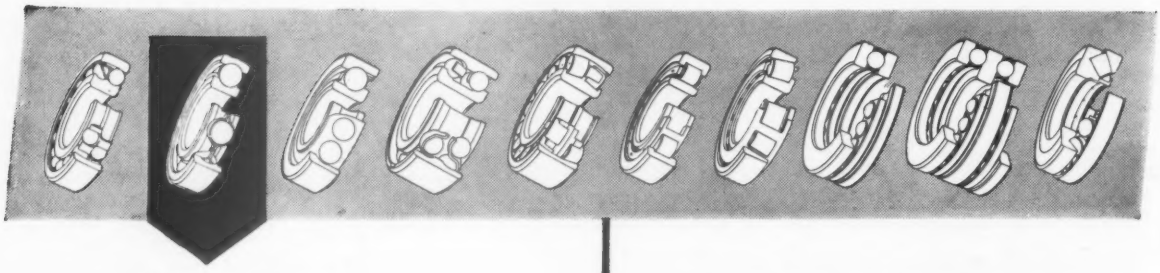
To ensure complete mechanical interchangeability of motors of different make, the application of standard dimensions, established in B.S. 2083 for totally enclosed fan-cooled motors has now been extended to electric motors with enclosures of the protected, screen-protected and drip-proof types. In addition to the advantages of interchangeability, B.S. 2960 breaks new ground in the introduction of standard dimensioned motors using the recently developed Class E insulating materials which permit a temperature rise of up to 65° C in maximum ambient temperature of 40° C.

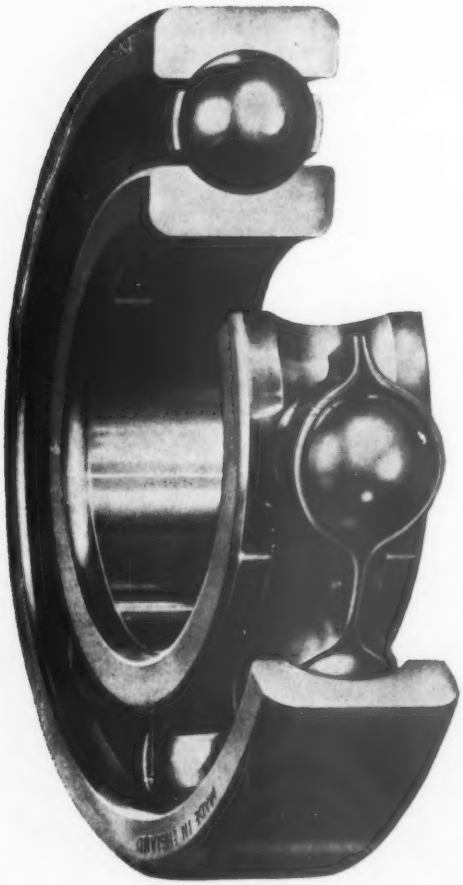
The standard applies to 3-phase, 50 c/s squirrel cage, ventilated motors with continuous maximum ratings in the range 1 to 40 hp (at 1500 rpm synchronous speed) at voltages up to 650 V. The motors are of the foot-mounted, flange-mounted and skirt-mounted types.

For certain specialized applications where it may not be possible to operate motors up to the maximum temperature permitted with Class E insulation information on operating temperatures is given in an appendix which includes a series of standard motor frames with corresponding reduced horsepower outputs.

An addendum to the standard is being prepared which will give maximum overall dimensions to enable a user to determine the minimum space requirements of any make of motor.

Only SKF *can offer such a wide selection of British made bearings*

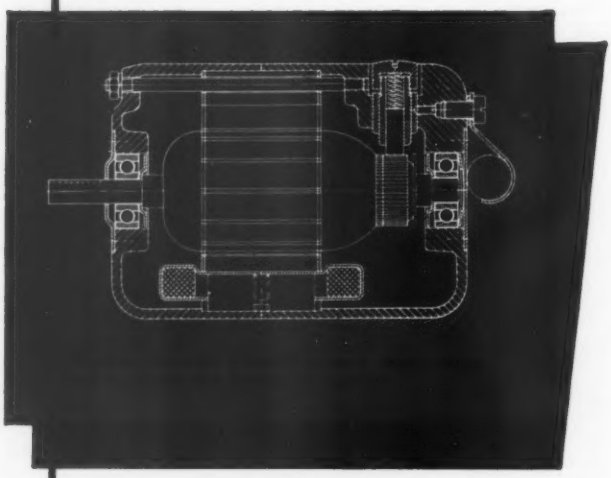




Illustrated here is the single row deep groove ball bearing, the most widely used of the ten variants of the four basic types of ball and roller bearing made by The Skefko Ball Bearing Co. Ltd.

The groove depth, ball size, and high degree of conformity between balls and tracks enables SKF single row deep groove ball bearings to deal with considerable thrust loads in addition to radial loads even at very high speeds.

A unique fund of technical information and experience lies behind the design of every SKF bearing—experience which is freely available to you whenever you have a bearing problem.



THE SKEFKO BALL BEARING COMPANY LIMITED · LUTON · BEDS

THE ONLY BRITISH MANUFACTURER OF ALL FOUR BASIC BEARING TYPES: BALL, CYLINDRICAL ROLLER, TAPER ROLLER AND SPHERICAL ROLLER

G172b

BUSINESS & PROFESSIONAL

Personal

METROPOLITAN - VICKERS ELECTRICAL Company Limited, announces the appointment of **Mr. A. E. Grimsdale, B.Sc.(Eng.)**, formerly manager, home sales, as director and commercial manager. Mr. Grimsdale has been a director of Metropolitan-Vickers Electrical Export Company Limited since 1954.

Mr. R. H. McCall has resigned from the Charles Churchill group of companies.

Lt.-Col. S. J. M. Auld has joined the board of directors of Industries Group Sales Limited.

DOWTY GROUP LIMITED announce the appointment of **Mr. L. S. Flatman, C.B.E., A.M.I.Mech.E.** to the board of Dowty Hydraulic Units Limited, Ashchurch, Gloucestershire, as production director.

Mr. Gordon Grant, C.B., an under secretary of the Board of Trade has been appointed Comptroller-General of Patents, Designs and Trade Marks with effect from March 3.

THE EXPORT CREDITS GUARANTEE DEPARTMENT announces the retirement of **Mr. W. E. Knox, C.M.G.**, director of its administration division. He will be succeeded by **Mr. F. H. Whitaker, O.B.E.**, formerly in the industries and manufactures department of the Board of Trade.

REFRACTORY MOULDINGS AND CASTINGS Limited, of Kegworth, Near Derby have appointed **Mr. J. F. Gardner**, of 7 Newlands Avenue, Melton Park, Gosforth, Newcastle upon Tyne, their representative for the Northern Area. Mr. Gardner has been connected with the foundry trades for many years, and is a member of the Institute of Metals.

ROSITE LIMITED of Cheney Manor, Swindon, Wilts., announce the appointments of **Mr. B. W. Hymass** as manager and **Mr. J. G. Selby** as sales manager of the company. Mr. Hymass had previously spent 11 years with the components division of The Plessey Company Limited and Mr. Selby was formerly sales manager of Insulators Limited.

Mr. A. W. Kirton an associate member of the Institute of Materials Handling, and well-known in the mechanical handling industry, has been appointed technical representative for British MonoRail Limited, (Wren Works, Chadderton, Lancs.) South West Area.

THE secretary of the George Cohen 600 Group Limited, **Mr. N. G. P. Boswood**, has been appointed a director of The Colchester Lathe Company Limited, a member company of the 600 Group.

Two further appointments are announced to the sales organization of Bowmaker (Plant) Limited of Willenhall. **Mr. J. P. M. Edwards** has been promoted to commercial manager and **Mr. Douglas E. Speight** is appointed sales representative for Shropshire and North Staffordshire.

FORMERLY London sales representative of Fielding & Platt Limited, of Gloucester, **Mr. S. G. Medcraft**, has now been appointed the company's sales manager.

Mr. B. S. Whitty, who for many years has been connected with the purchasing and supply side of British Thermostat Company Limited, has been appointed a director of the subsidiary company, P. W. Baker & Sons Limited of Sunbury-on-Thames. **Mr. W. C. Hopkins**, who has been connected with the parent company for many years, is also joining the board.

Mr. David Brook, son of the chairman of directors of Brook Motors Limited, Mr. Frank V. Brook, has been co-opted to the board. Mr. David Brook holds an executive position with the company.

Mr. David C. Nutting, M.B.E., A.R.C.S., B.Sc., A.Inst.P., A.M.I.E.E., recently joined the board of Solartron Industrial Controls Limited, a member company of The Solartron Electronic Group. He is a full-time director responsible for processing contracts for the design and manufacture of electronic control systems for all manufacturing industries and for the sales of industrial control instruments.

ON being appointed chief executive director of British Oxygen Gases Limited, **Mr. J. Strong**, a director of the British Oxygen Company, has relinquished his appointment as chairman of Quasi-Arc, Limited.

Mr. J. H. Mayes, general sales manager of Northern Aluminium Co. Limited, has been appointed to the board of directors. Mr. Mayes joined the company in 1934, in the technical section of Banbury Works.

ELLIOTT BROTHERS (LONDON) LIMITED have pleasure in announcing that **Mr. George C. Fairbanks, M.I.P.E.**, a deputy general manager of the company, has been appointed a director. Mr. Fairbanks, who is 48, joined Elliott Brothers in 1930 as a toolmaker.

Mr. H. E. Bayman has retired from Chloride Batteries Limited where he was manager of Exide and Drydex replacement sales. He had been with the company for 25 years and members of the staff presented him with a set of three fishing rods and tackle and a book case.

Mr. J. Fairclough, who has over 30 years' service with Leyland Motors Limited, has been appointed chief buyer and will be responsible for all buying connected with the headquarters group of factories comprising the Leyland, Farington, Chorley and Spurrier works.

Mr. L. A. C. Bartlett, A.M.I.Mech.E., has undertaken the supervision of the steering-gear division of George Kent Limited, and is relinquishing his duties as commercial director of the instrument division. As a result of this change and to give closer liaison between the sales and the research and development organizations, **Mr. R. S. Medlock, B.Sc., A.R.I.C., A.M.I.Mech.E., A.M.I.E.E.**, has been appointed as technical and home sales director, with responsibility for the contracts department, home sales representatives and service and erection in addition to his duties as director in charge of research and development. **Mr. W. T. H. Carter** has been appointed chief buyer for the instrument division.

SIEMENS EDISON SWAN, Limited, announce the appointment of **Mr. B. A. Hensler** to their board of directors. Mr. Hensler, who is managing director of Siemens Edison Swan (Export) Limited, is also on the boards of the company's overseas subsidiaries, and that of Associated Electrical Industries (Overseas), Limited.

Mr. J. Russell Knowles retired from business on January 31, 1958, after nearly fifty years' service with Gulf Oil (Great Britain) Limited and twenty-five years' as managing director. **Mr. Norman Edmenson** has been appointed to succeed Mr. Knowles as managing director and **Mr. J. R. Smellie** has been appointed vice-managing director.

Mr. S. Teasdale has been appointed technical representative in the North-West for Martonair Limited.

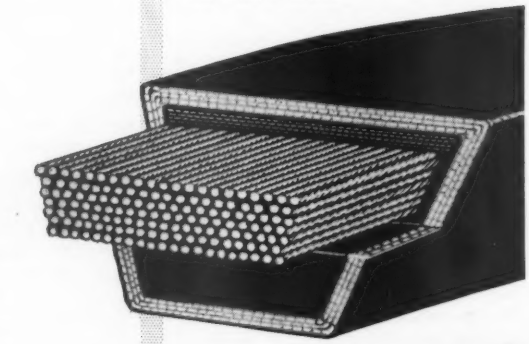
AFTER 39 years' service with the British Thomson-Houston Company, Rugby, **Mr. E. G. James, B.Sc., A.M.I.E.E.**, has now retired. Mr. James spent most of his career in the industrial engineering department but for the past two years has been personal assistant to Mr. G. S. C. Lucas, director and chief electrical engineer.

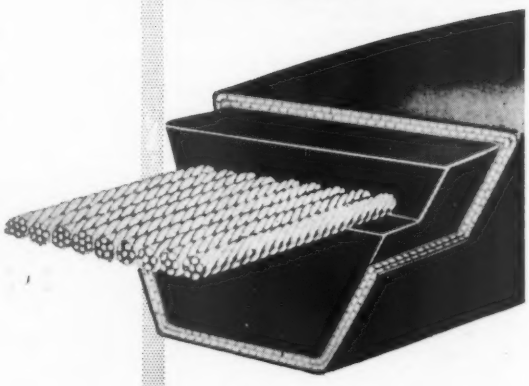
Mr. L. E. Nichols has resigned his post as area engineer in the North-East of the National Industrial Fuel Efficiency Service, and is proposing to re-enter consulting engineering practice. For the time being, **Mr. George Gill**, area engineer in the North-West, will also be exercising general supervision over the Leeds, Sheffield and Newcastle offices.

Mr. P. H. Muirhead, C.B.E., has resigned his appointment as managing director of

V-BELTS THAT ARE BUILT TO LAST!

on multi-V Drives





and on F.H.P. Drives

YOU BUY ENDURANCE when you buy Goodyear V-Belts, made in types and sizes to suit every job from the largest multi-V installations to small F.H.P. drives. Longer belt life, more efficient transmission, less risk of costly shut-downs — these are the positive benefits of making good use of the Goodyear 'job-designed' range of belts which are backed by more than fifty years' experience in rubber engineering.

To be sure of longest, most economical performance it pays to consult Goodyear or your Goodyear Industrial Distributor, who will recommend a suitable belt, and also advise on installation and maintenance.

GOODYEAR

V-Belts · Conveyor Belting · Transmission Belting · Hose · Fenders

THE GOODYEAR TYRE & RUBBER COMPANY (GREAT BRITAIN) LIMITED · WOLVERHAMPTON

Vickers-Armstrongs (Engineers) Limited and his directorship of that company. He retains his other group directorships for the time being, but remains on sick leave. **Mr. W. D. Opher, M.I.Mech.E.,** succeeds Mr. Muirhead as managing director of Vickers-Armstrongs (Engineers) Limited, and he has also, together with **Mr. R. P. H. Yapp,** been appointed special director of Vickers Limited.

THE INSTITUTION OF MECHANICAL ENgineers has awarded the 1957 James Clayton Prize to **Dr. Allan William Davis** and **Dr. Paul de Kantzow Dykes.** The award to Dr. Davis was made for his contributions to marine engineering communicated in part in a Thomas Lowe Gray lecture, and to Dr. Dykes for outstanding research and experimental work in the behaviour and functioning of piston rings for high speed internal combustion engines, communicated in part in a paper presented to the Institution.

UDDEHOLM LIMITED the British associates of Uddeholms AB of Sweden have appointed **Mr. S. A. Comley** as London area manager, tool steel division. Mr. Comley who has been the firm's tool steel representative in the Birmingham territory for the last five years, will operate from 6-10, Dean Farrar Street, Westminster, London SW1. (Telephone: WHItehall 9233). He is succeeded at Birmingham by **Mr. A. G. Shaw,** who has been actively associated with tool steels for a period of ten years.

Mr. G. F. Laurence who joined Metalastik Limited, Leicester last year as personal assistant to Mr. M. Goldsmith, chairman and managing director, has been appointed to the board.

BRITISH RAILWAYS SCOTTISH REGION announces the appointment of **Mr. M. Harbottle, A.M.Inst.C.E.,** as district engineer, Inverness.

Mr. Malcolm Turner Clark has been appointed chief chemist at the Cricklewood laboratory of British Oxygen Gases Limited. He succeeds **Mr. C. Coulson-Smith** who has retired.

VICKERS-ARMSTRONGS LIMITED announce that **Mr. R. J. W. Rudkin, B.Sc., M.I.N.A.,** has been appointed general manager, naval yard, with effect from January 1, 1958, and is directly responsible to the shipbuilding general manager of Vickers-Armstrongs (Shipbuilders) Limited (Mr. L. Redshaw, M.Eng. M.I.N.A., M.Inst.W.).

Obituary

WE regret to record the death of **Mr. K. D. Marsden** who, for more than 30 years, had represented J. A. Crabtree & Co. Limited, in North Wales and West Lancashire. He received his early engineering training with the Renault company of France and joined the Crabtree Company in 1925.

WE regret to record the death of **Mr. F. D. Ascoli, C.I.E., F.I.R.I.,** managing director of Dunlop Plantations Limited until his retirement in 1955, and a former president of the Institution of the Rubber Industry.

WE regret to record the death of **Mr. John Scowcroft Ramsden, M.I.E.E.,** who, until his retirement in 1950, was on the board of directors of the British Thomson-Houston Co. Limited. Mr. Ramsden served the company for 40 years—15 of them as a senior commercial director.

WE regret to record the death of **Mr. H. T. Eatwell, A.M.I.E.E.,** director and joint deputy chairman of G. A. Harvey & Co. (London) Limited.

Addresses

YORKSHIRE IMPERIAL METALS LIMITED, Leeds, a new company formed on February 1, 1958, has accepted liability for all purchase orders and contracts placed before that date by The Yorkshire Copper Works Limited. Invoices, etc., should be sent to the new company at Haigh Park Road, Leeds.

AN additional exchange line has been connected at Aberdeen branch office of British Insulated Callender's Cables Limited and the new telephone numbers are: Aberdeen 53351/2.

BRITISH INSULATED CALLENDER'S CONstruction Co. Limited Glasgow office address has been changed, and is now 110A Maxwell Avenue, Westerton, Bearsden, Glasgow. The new telephone numbers are: Bearsden 2382 and 3.

W. E. SYKES LIMITED, of Staines, Middlesex, manufacturers of gear cutting and hobbing machines and tools, have opened new offices at Grove House, Sutton New Road, Erdington, Birmingham 24 (Telephone: Erdington 7491). The company's Midlands representative, Mr. P. Franks, is now operating from the new offices, which are designed to improve the facilities and service available to customers in the Midlands.

SPE CO. LIMITED, is the new name of the Self-Priming Pump and Engineering Co. Limited, of Trading Estate, Slough, Bucks. The London office of these aeronautical, electrical, mechanical, and hydraulic engineers is now at 20/26 Lamb's Conduit Street, London WC1.

THE electronics division of Irwin Technical Limited, which is fully equipped to cope with every type of text, illustration, or circuit diagram required for technical publications in this specialised field, has taken over larger premises at 6 Warwick Court, Holborn, London WC1.

MARTONAIR LIMITED have opened a new branch office at 71 Carver Street, Sheffield 1. (Tel: 21641), at which they will carry stocks of pneumatic cylinders, valves and accessories.

D. ROBINSON & COMPANY new address is Gunnersbury House, 717 London Road, Hounslow, Middlesex. Telephone Hounslow 6266-7.

THE address of Foxboro-Yoxall Limited is now Redhill, Surrey. Telephone: Redhill 5000. Telegrams: Yoxbri, Redhill, Surrey.

THE address of the Midlands office of Wild-Barfield Electric Furnaces Limited, is now 71 Broad Street, Birmingham 15. Telephone number Midland 7232.

THE new address of The Professional Engineers Appointments Bureau is now 39 Victoria Street, London SW1. The telephone number remains unchanged (ABBey 1737).

Printers' Engineers Company Acquired

THE whole of the issued share capital of Furnival & Company Limited, printers' engineers established at Reddish in 1859, has been acquired by the Stockport centrifugal pump manufacturers, Rhodes, Brydon & Youatt Limited. Members of the new board of directors are: Mr. Geoffrey Parkes, C.M.G., J.P., chairman; Mr. Norman Youatt, M.I.Mech.E., deputy chairman; Messrs. H. R. Thompson, W. Latta, J. Johnson, R. L. Furnival and F. Furnival.

New Belgian Office

A new branch office in Brussels will help Evershed & Vignoles Limited to cope with the expansion of their overseas activities. The office, which opens on April 1 under the management of Mr. C. Samyn—for several years the company's Belgian agent—will serve the whole of Belgium, Belgian Congo, and the Grand Duchy of Luxemburg in the company's range of electrical instruments and control equipment. The address of the new branch is Evershed & Vignoles Limited, Succursale,. 142 Rue Gallait, Bruxelles.

Raw Materials U.K. Agency

THE distribution in the United Kingdom of materials manufactured by the J. M. Huber Corporation (100 Park Avenue, New York 17) is being effected by Durham Raw Materials Limited of 1-4 Great Tower Street, London EC3, who took over this agency in January last. The materials, in addition to their well-known carbon blacks, include Zeolex (an aluminium silicate reinforcing agent, Turgum S, Butac and Nutac, (rubber rosins with specific uses) Actone, an activator/accelerator, and a range of hard clays of which there are no British equivalents.

RAWLPLUG

DURIUM

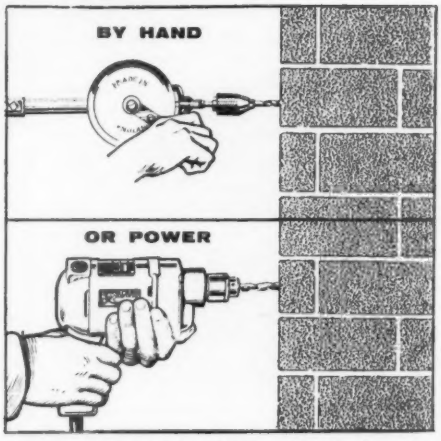
Registered Trade Mark

The world's FASTEST masonry drill

DURIUM is the drill that revolutionized masonry drilling, staggering the industrial user with its amazing speed of penetration and sharp, silent, easy-cutting *accuracy!* With its tough, almost diamond-hard Durium tip, and its patented rapid-helix flute to force out spoil and prevent clogging, the Durium Drill penetrates masonry of all kinds at a speed unequalled anywhere in the world.

and the most durable

Just as important to your costs is the extraordinary *durability* of Durium Drills. Remember that masonry is an *abrasive* material which quickly ruins ordinary drills. The astonishing *toughness* of the Durium tip, and the stronger backing of steel given it by the specially designed flute, makes Durium Drills the world's most durable masonry drill.



R.P.I. ELECTRIC DRILL This is the ideal power tool for use with Durium Drills. With a full load speed of 450 r.p.m. it combines high torque with a weight of less than 5 lbs.

Free resharpening service

When, at long last, your Durium Drill begins to lose its keenness, return it to us with the complimentary voucher supplied with it, and we'll re-sharpen it FREE! Write now for full details of these fastest-of-all masonry drills.

Sold in the bright orange and blue metal container clearly marked Rawlplug Durium.

Look for the name DURIUM on the drill shank, no other is a genuine DURIUM Drill.

THE RAWLPLUG COMPANY LTD., CROMWELL ROAD, LONDON, S.W.7

Birfield Engineering Division

THE new Engineering Division recently formed by Birfield Industries Limited, Sales Organization of the Birfield Group, will co-ordinate the selling activities of the Group in conjunction with the existing automotive, railway and aviation divisions. Birfield companies whose activities will principally be covered by the new division are: The Phosphor Bronze Company Limited, Railko Limited, Forgings & Presswork Limited, Laycock Engineering Limited, Shotton Bros. Limited, Kent Alloys Limited, Birfield Tools & Designs Limited, Kolene (G.B.) Limited, R. Jones & Company Limited.

35 Years

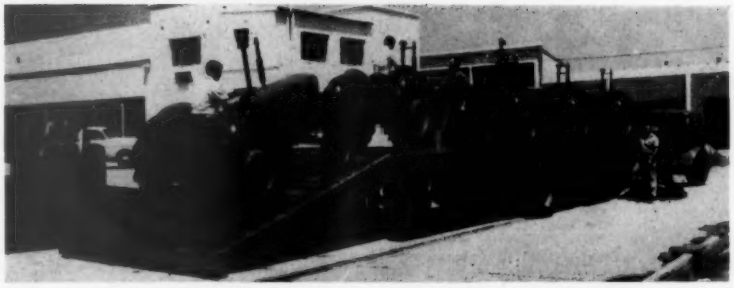
AT a ceremony at G. A. Harvey & Company (London) Limited held in January last, 77 members of the office and works staff were presented with long service awards. All have completed over 35 years' continuous service and all received engraved watches presented by the wife of the President of the company, Mrs. Sydney Harvey. Hitherto the qualifying period for such awards was 50 years, and guests of the directors included four employees in this category who were the holders of gold watches.

25 Years

THE 500th employee of The Skefko Ball Bearing Company Limited, Luton, was recently presented with a specially inscribed fountain pen and savings certificates. He is Mr. C. H. Peddar of the automatic turning department. The company still has in its employ 350 persons with 25 or more years' service behind them. At the same ceremony Mr. C. U. Magnusson, the company's managing director, presented the Mayor of Luton with a cheque for the purchase of some trophy or piece of plate to mark Skefko's long association with the Borough of Luton.

Film News

The Whole Works.—Modern work study techniques form the subject of this film made available by the British Productivity Council. The advent of a European Free Trade Area makes necessary a scrutiny of commodity prices, and many industrial organizations in this country are examining the possibility of reducing prices by making more effective use of their materials, capital and labour. The theme of the film, which was shown many times early last year, is the complete reorganization of a large engineering firm of 4000 employees. It was made at the Edmonton factories of British Oxygen Engineering Limited and British Oxygen Gases Limited (equipment division).



AUSTRALIAN-MADE DAVID BROWN TRACTORS:— The first batch of Australian-made David Brown 900 tractors being despatched from the new Lidcombe (N.S.W.) factory of David Brown (Australasia) Pty. Ltd. The factory was completed in mid-1957

Official Stockholders for I.C.I.

RECENTLY appointed as official stockholders of non-ferrous metals for Imperial Chemical Industries Limited, Metals Division, all materials henceforth supplied by Henry Righton & Company Limited will be exclusively of I.C.I. manufacture. The new premises in Pentonville Road have been specially designed for the storage and rapid handling of metals and, being carefully temperature controlled, enable materials to be maintained in mill condition. A comprehensive Stock and Weights booklet, giving detailed information of the range available, will be supplied on request.

Wilmot Breeden Fellowships

Two Fellowships, each tenable for two years and each of a value of £1000 p.a., are to be offered by the Wilmot Breeden group of companies of Birmingham (manufacturers of motor vehicles, gas turbine components, hydraulics and electronics). One will be held at Birmingham University and the other at Birmingham College of Technology. Successful candidates will divide their time between the company and the teaching institution. The Fellowships will be advertised each March and will alternate between the University and the College of Technology. The appointment in 1958 will be to the College Fellowship, and that in 1959 to the University Fellowship and each thereafter at two-yearly intervals. Candidates should hold an honours degree at a university within the British Commonwealth, or equivalent, and must outline a two-year investigation or project on which they propose to work. Application forms may be obtained from The Secretary, Wilmot Breeden (Holdings) Limited, Amington Road, Birmingham 25.

C. C. Wakefield and Fletcher Miller

THE entire share capital of Fletcher Miller Limited, Alma Mills, Hyde, Cheshire, (the parent company of a group of ten companies) is to be acquired by C. C. Wakefield & Company Limited.

South African Agency

BILL SWITCHGEAR LIMITED have appointed Coombe & Bicknell (Pvt) Limited, P.O. Box 1782, Salisbury, Southern Rhodesia, as agents for the Federation of Rhodesia and Nyasaland.

Contracts and Work in Progress

DAVID BROWN COMPANIES, Huddersfield.—Order for two large machines capable of producing turbine gears and pinions up to 220 in. and 60 in. dia. respectively, for a Nantes (Brittany) firm.

Contract from British commercial vehicle manufacturers for 500 gearboxes from David Brown Industries Limited automobile gearbox division, Huddersfield.

G. & J. WEIR LIMITED, Glasgow.—Order for 20 Weir feed pumps from Simon-Carves Limited for the Hunterston nuclear power station for the South of Scotland Electricity Board.

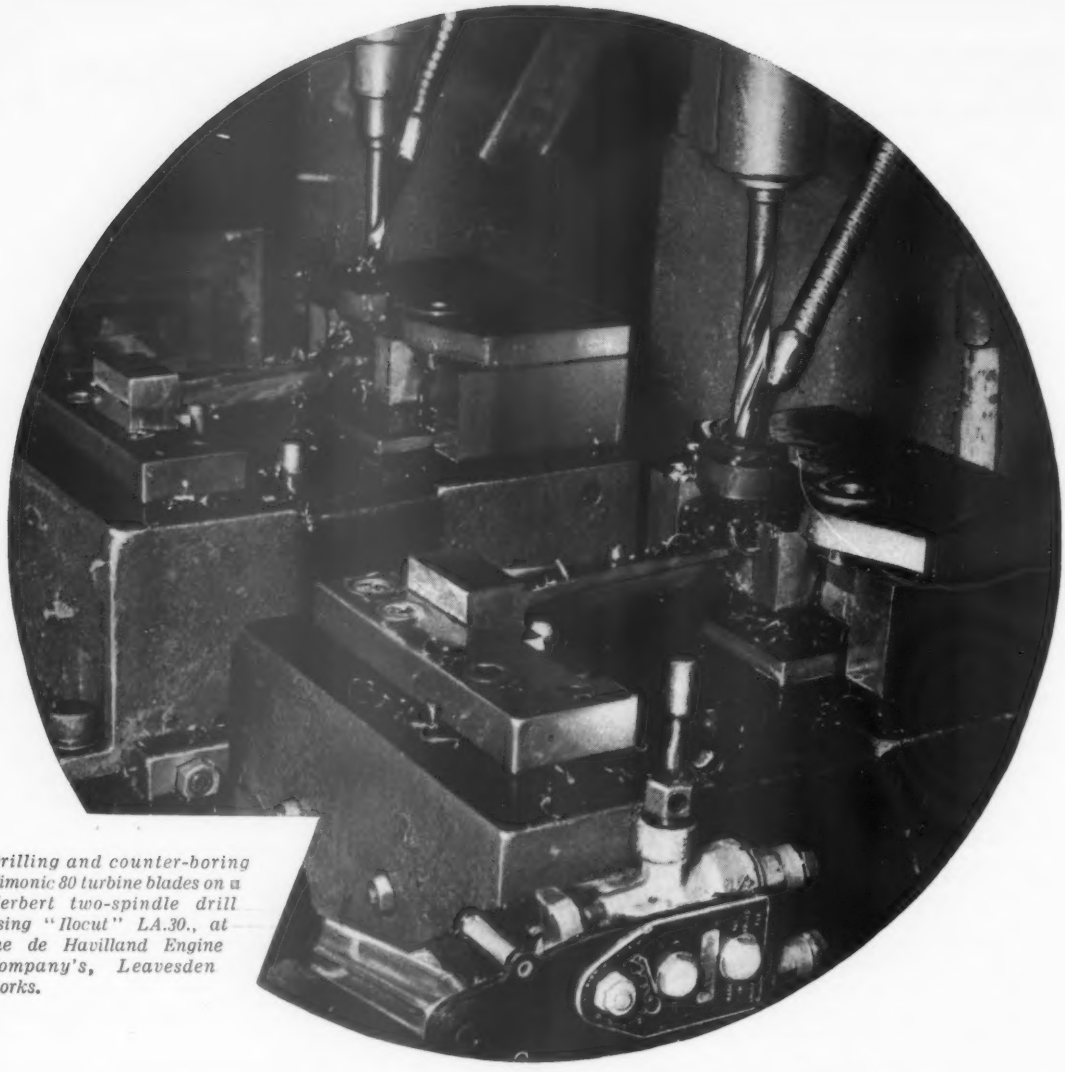
HEENAN & FROUDE LIMITED, Worcester.—Heenan Torque Reactor Stand for Pakistan International Airlines at Karachi airport.

A cable suspended hangar stand supplied to Air India International for testing piston type aircraft engines is now in operation at Santa Cruz airport, Bombay.

Large preliminary order from G. W. King Limited, for more than 60 Heenan-Dynamatic electrically controlled couplings. Messrs King are the main contractors for the reorganization of the conveyor system at Briggs Motor Bodies Limited, Dagenham.

WORTHINGTON-SIMPSON LIMITED, Newark-on-Trent.—Condensing, feed-heating, distilling and de-aerating plants, together with boiler feed pumps and circulating pumps for the five 120MW turbo-alternators for the new Buenos Aires Power Station.

NATIONAL GAS & OIL ENGINE CO. LIMITED.—Contract for four National R4AP four-cylinder dual fuel engines for a new sewage purification plant for the Christchurch (N.Z.) Drainage Board.



Drilling and counter-boring Nimonic 80 turbine blades on a Herbert two-spindle drill using "Ilocut" LA.30., at the de Havilland Engine Company's, Leavesden works.

"ILOCUT"

NEAT CUTTING OILS

—used by THE DE HAVILLAND ENGINE CO. LTD

"They possess exceptional cutting and surface finish properties . . . and cooling qualities which ensure long tool life between regrinding."

Those are the outstanding reasons for the pre-eminence of the "Ilocut" range of Neat cutting oils. In the de Havilland group the Engine Company and the Propeller Company both use "Ilocut". Also, in common with the de Havilland Aircraft Company, they use many of our other oils. May our technical engineers call, and tell you all about our production oils? Also available to your company, a complimentary copy of "Cutting & Metalworking Oils".

INDUSTRIAL WAKEFIELD-DICK LUBRICANTS

WAKEFIELD-DICK INDUSTRIAL OILS LTD • 67 GROSVENOR ST., LONDON, W.1

A MEMBER OF THE WORLD-WIDE WAKEFIELD CASTROL ORGANISATION

Heavy Duty Propane Regulator

A heavy duty, single stage regulator which is suitable for propane and other liquid petroleum gases used for heating and cutting applications is announced by British Oxygen Gases Limited (Industrial Division), Spencer House, St. James's Place, London SW1.

The regulator known as Type P.R.1., has been specially developed for use in steel works, shipbuilding yards and heavy engineering works. The maximum outlet pressure of the regulator is 30 psi and the maximum flow rate is approximately 300 cfh.

Electricity in Industry

The 14th issue of Electricity in Industry—technical review of the Lancashire Dynamo Group of Companies—has been published. The four main articles are concerned with recent developments in the field of variable speed drives, rolling bearings for small motors, vehicle battery charging and transformer core steel. The latter article is one of a series which, in this issue, covers methods of use and processing of high grade transformer core steel. Copies of the publication are available from Lancashire Dynamo Group Publicity Services, St. Stephen's House, Victoria Embankment, SW1.

Chisels

A new catalogue describing the range of chisels available to suit pneumatic hammers, riveters and cutters, has been issued by The Consolidated Pneumatic Tool Company, 232 Dawes Road, London SW6.

This 8-page brochure is the fourth section of their accessories catalogue and contains detailed information regarding 38 types of chisel available, ranging from flat and peg pointed chisels for general work to special chisels for caulking, paint scraping and rivet cutting.

Solder Paints and Pastes

A number of technical information information sheets on the use of Epatam 3311 solder paints and pastes are now available from the makers, Perdeck Solder Products Limited, Abbey Mills, Waltham Abbey, Essex. These powerful de-greasing fluxes are suitable for stainless steels, mild steels, cast iron, brass and copper components.

Machining Laminated Plastics

A handbook intended as a code of practice for the user of parts machined from laminated plastics sheet, tubing, rod and moulded sections; particularly those having a paper, woven fabric, or wood veneer filler has been prepared by the British Plastics Federation.

The handbook entitled "Tolerances for the Machining of Thermosetting Laminated Plastics" is obtainable from the British Plastics Federation, 47–48 Piccadilly, London W1, price 2/6, post free.

Swinging Arm Ladle Heater

A new design of adjustable swinging arm ladle heater for preheating all sizes of foundry ladles is now available from Monometer Manufacturing Company Limited, Savoy House, 115–6 Strand, London WC2. Firing is by low pressure air-regulated fuel oil burner or gas as desired. Further details are contained in an illustrated leaflet.

Tin and its Uses, No. 41, Winter, 1957

This issue contains a review of progress towards the attainment of "bright" coatings of tin applied by electrodeposition. Whilst it is already practicable to produce a shiny or nearly mirror-bright tin coating by electrodeposition the process is not yet at the fully commercial stage though several firms are operating the process under the Institute's guidance.

Trade Literature

Another development featured is the introduction of the "reticular" structure in bearing metals consisting of 80% aluminium permeated to the extent of 20% by a veiny network of tin. Reticular aluminium-tin bearings are being produced commercially in England for use as main and big-end bearings in petrol and diesel engines for which purposes they have several advantages over the older three-layer type of bearing and are cheaper to produce. "Tin and Its Uses" No. 41 is available free of charge on request to: Tin Research Institute, Fraser Road, Perivale, Greenford, Middlesex.

The Solartron Annual Review for 1957

A handsome brochure, entitled "The New Horizons of Discovery" has been issued by The Solartron Electronic Group Limited, Thames Ditton, Surrey, and provides a concise review of their past year's achievements.

Of the new machines the review includes references to the Solartron ERA (p. 4–6); the first of a family of cybernetic teaching machines produced in collaboration with System Research Limited, for training accounting machine operators (p. 7); SPACE (Solartron Precision Analogue Computing Equipment on the modular or "brick" approach) for "Building your Own Computer" for a specific problem (p. 10); the Solartron Radar Simulators (p. 12); precision instruments for testing rockets, satellites, etc. (p. 14) and Solartron high-speed electronic checkweigher (p. 19).

Panel and Switchboard Instruments

Rectangular, square and round flush pattern moving coil panel instruments are the respective subjects of three new publications MS/4022, MS/4021, MS/4020 issued by The English Electric Company Limited, Stafford. Each instrument employs high flux density magnets which provide high torque with low power consumption. Square and round flush mounting moving coil instruments for switchboards are featured in further publications, MS/4019 and MS/4018.

Investment Casting and Shell Moulding Techniques

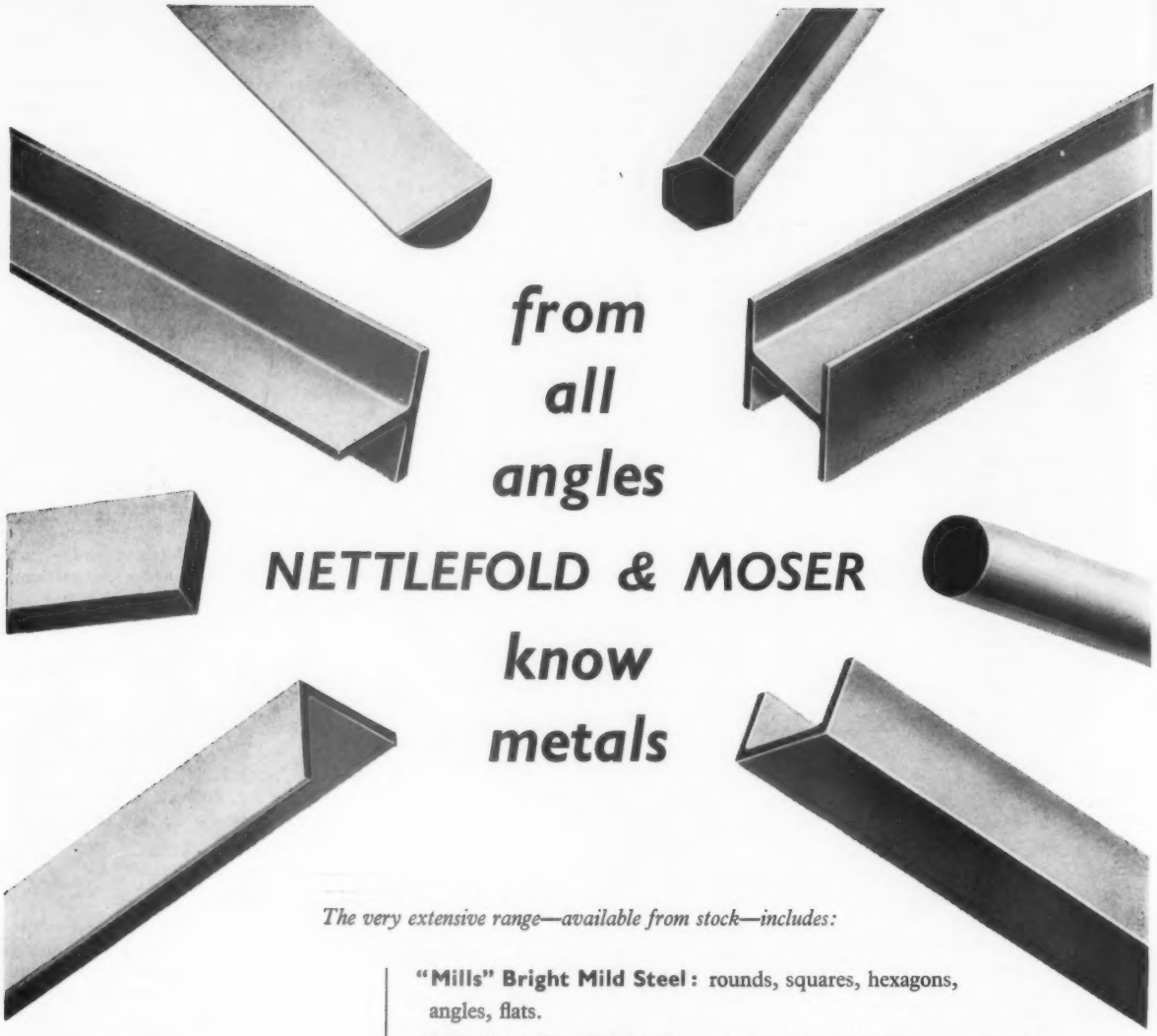
A series of illustrated examples of work produced by specialized foundry methods are given in leaflet No. 530, published by Hadfields Limited, East Hecla Works, Sheffield 9, to encourage the use of precision castings to cut down machining costs.

Nucleonic Gauges

Increasing application of nucleonics to industrial quality control is amply portrayed in a handsome brochure published by Ekco Electronic Limited, Ekco Works, Southend-on-Sea, Essex, which covers their range of nucleonic gauges. Three systems of non-contact measurement are described and tables set out the range of measurement for Promethium 147, Strontium 90, Thallium 204 and Cerium 144 sources. Other pages cover the practical applications of the systems and the equipment required.

Screw or Pin Driving Machines

The range of Russell screw or pin-driving machines and attachments forms the subject of a descriptive leaflet published by Russell Auto-feed Screwdrivers Limited, Studley, Redditch. A range of heads is available for wood, machine or self-tapping screws having any kind of head in sizes up to $\frac{1}{4}$ in. dia $\times$ $2\frac{1}{4}$ in. long and as small as ·056 in. dia $\times$ $\frac{1}{4}$ in. long. Machines shown include motorized bench models (hand operated) single cycle pneumatic bench models (foot or hand operated) and continuous cycle pneumatic bench machines for automatic operation.



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Bedlington. Work is to start on extensions (3500 sq ft) to factory for Remploy Ltd. The contractors are Tate and Holmes Limited, Benwell, Newcastle-on-Tyne.

Billingham-on-Tees. The construction of a sulphuric acid plant at the works of British Titan Products, Limited is proposed.

Carlisle. Factory alterations are proposed in Rome Street for J. T. Scott and Company Limited, leather factors. The architect is W. R. Heffrey, 24 Bank Street, Carlisle.

Durham. R. E. Coleman Limited, Western Hill, Durham, are to erect a warehouse at Gilesgate for the Distillation Company Limited, London.

Hebburn (Co. Durham). A. Reyrolle and Company Limited are to extend their No. 2 machine shop and plans have been approved. The architects are Cackett, Burns Dich and Mackellar, 21 Ellison Place, Newcastle-on-Tyne.

Newcastle upon Tyne. C. A. Parsons and Company Limited, electrical plant manufacturers, have announced a million pounds plan for building modern research laboratories on land fronting the Fossway, Newcastle. Workshops are also to be erected at Longbenton and at Walkergate Works. The firm prepare their own plans.

Beecham Foods Limited, Brentford, Middlesex, are to erect vehicle maintenance and servicing depot and have prepared their own plans.

Hall, Forster and Company are to erect offices, warehouse and packing department in Temple Street. The architects are Tasker and Partners, 25 New Bridge Street, Newcastle.

North Shields. Gregson and Company Limited, London EC3, are to construct a factory on the site of the former Northumberland Shipyard, for the making of boats and launches.

Penrith. Gush and Dent Limited, manufacturers of farm and dairy equipment, Arelsford, Hants, are considering the erection of a factory at Castletown, Penrith.

South Shields. Newrick and Blackbell, 58 John Street, Sunderland are the architects for factory alterations on the Bede Estate for Cigarette Components Limited.

Stockton-on-Tees. Bakery additions are to be carried out in Bishopton Avenue for R. Sparks and Sons. Contracts are not expected to be arranged for some time. The architects are Kitching and Company, 21 Albert Road, Middlesbrough.

The Quayside Engineering Company Limited, Stockton are to buy land in Haverton Hill Road for a factory.

The South Durham Steel and Iron Company Limited are to extend their pipe department in Portrack Lane.

Ashmore Benson Pease and Company Limited are to erect a three storey office block in Yarm Road, Stockton. The architect is A. J. Elder, 65 Albert Road, Middlesbrough.

Sunderland. J. L. Thompson and Sons, shipbuilders, are to spend between £30,000 and £40,000 on the construction of a shot-blasting plant to remove scale from the plates of oil tankers.

Matkin and Hawkins, Barclays Bank Chambers, Fawcett Street, are the architects for proposed bakery additions in Selbourne Street for Earnshaw Brothers, Chester Road, Sunderland.

Wallsend. The Esso Petroleum Company Limited, Queen Anne's Gate, London SW1, are expected to start work this summer on the construction of an oil distribution depot on a 60 acres site at Howdon-on-Tyne.

Clelands (Successors) Limited, shipbuilders, Willington Quay are seeking permission to use land east of Willington Gut for proposed shipbuilding berths.

Plans have been approved for a primary gear shop for Parsons Marine Turbine Company Limited. The contractors are A. and J. Main Limited, Glasgow N2.

Acton. A new factory is to be built on the Great Western Trading Estate, Park Royal Road, for J. A. Launder and Company Limited.

Bagshot. Extensions are to be made to the works of Tratt Plastics Limited, Carlton Works, Macdonald Road.

Belfast. Blackwood & Jury, Donegall Place, are the architects for a new factory to be built at the junction of Waring Street and Victoria Street for Pratt & Montgomery Limited.

New Factories

Birmingham. The architects for extensions to the factory of Weathershields Limited, Sherlock Street are P. Skelcher & Partners, Lloyds Bank Chambers, 17 Poplar Road, Solihull.

Blackburn. Extensions are to be made to Griffin Works, Stancliffe Street, for Newmans Slippers Limited.

Bletchley. A new factory is to be built in Watling Street industrial estate for Amos (Electronics) Limited, 45 High Street, Fenny Stratford.

Bolton. Extensions are to be made to the factory of R. Entwistle and Company Limited, Lincoln Mill, Washington Street.

Brighton. Extensions are to be made to the factory in Crowhurst Road for Underwood Business Machines Limited.

Burnley. Burco Dean Limited are to make extensions to their works on the Maden Fold industrial estate.

Houston & Forbes, Old Black Bull, Church Street, Padiham are the architects for a new factory to be built at Riley's Farm, Rossendale Road for the Regent Axle Company Limited, Marles Street.

Chesterfield. Plans have been approved for extensions to the works in Lordsmill Street for British Electrical Repairs Limited.

Coventry. A new factory is to be erected for Hawkesbury Gauge & Tool Company Limited, 268 Aldermans Green Road.

Crawley. Frys (London) Limited, tool merchants, 56 Southwark Street, London SE1, are to build a new factory in Faraday Road.

Darwen. The factory of Imperial Chemical Industries Limited, is to be extended.

Enfield. Scroll Pens Limited, Brimsdown, are to erect a new factory at Lockfield Avenue.

Glasgow. The Wyndford Works of Paterson Hughes Engineering Company Limited, in Lochburn Road is to be extended.

Hereford. The works of Painter Bros. Limited, Mortimer Road, is to be extended.

Hull. Extensions are to be made to Minster Works, Clough Road for Kingston (Architectural Craftsmen) Limited.

London. A new factory is to be erected in Cheap Lane, London E8, for L. Morris (Boxes) Limited, 14 Regents Row, London E8.

Lowestoft. Birds Eye Foods Limited, South Denes, Great Yarmouth are to build a new factory.

Luton. Rappaport Bros. are to make extensions to their hat factory in John Street.

Manchester. K. Newton, The Downs, Altrincham, is the architect for extensions to the factory in Longley Lane, Northenden, for Hind, Hoyle & Light Limited, Rice Street.

Morley. The works of Mechanical Equipments Limited, Commercial Street, is to be extended.

Newbury. A new printing works is to be erected at the rear of Northbrook Street for G. W. Simpson & Son Limited.

Nuneaton. The Regent Engineering Company, Tribune Works, Church Street, are to erect a new factory and offices at Tuttle Hill.

Oxford. A new factory is to be erected at Abingdon Road for W. P. Spearman Limited, Elms Road, Cassington, Eynsham.

Portsmouth. Fireproof Tanks Limited are to carry on with Stage II of their factory development at the airport.

Salford. Plans have been approved for extensions to the factory at Ordsall Lane for Boxmakers (Manchester) Limited.

Stretford. A new factory is to be erected in Talbot Road for Parkinson & Cowan (Gas Meters) Limited. The contractors are J. Jarvis & Sons Limited, Dane Road, Sale.

Walthamstow. S. Noton Limited have received permission for the erection of a new factory at Endurance Works, Blackhorse Lane.

Warrington. The works of Richmonds Gas Stove Company Limited, at Latchford are to be extended.

West Bromwich. Extensions are to be made to the factory in Kelvin Way for Jensen Motors Limited.

Willesden. Electroflo Meters Company Limited, are to spend £12,500 on partially rebuilding their factory at Abbey Road, Park Royal.

Worthing. Knapton & Deane, 6 Martin Lane, London EC4, are the architects for extensions to the factory in Brougham Road for the Marylebone Optical Company Limited.

Edinburgh. The North British Rubber Company Limited, are to build a boiler house and engine room at Castle Mills, Fountainbridge, as part of their project for the modernization of the works there to handle a wider range of rubber products on modern fully mechanized lines. The firm is now linked to an American rubber manufacturing concern which is behind the project. Cost of the construction at this stage is £75,000 which embraces boiler house buildings and ancillary equipment. Warrant has been given by the Dean of Guild Court for the work.

Falkirk. British Aluminium Company Limited of Falkirk, have received approval for the extension of their roll grinding shop at a cost of £3,000.

Laird-Portch Fashions Limited also of East Kilbride, making ladies' garments are planning a further extension.

Carron Company are opening a new 30,000 sq ft press and fabrication department to handle all classes of sheet metal and stainless steel fabrication for kitchen equipment, commercial and marine installations. The firm's Washington Street, Glasgow, plant and employees will transfer to this department.

Leith. Ralph Symonds Limited, plywood manufacturers of Sydney, Australia, are planning the erection of a factory at Leith Docks, Western Extension, and have reached agreement in principle with the Dock Commissioners. An associated Scottish firm is planned to undertake the manufacture of laminated plywood products and veneers.

Treforest, Glam. Firth Cleveland Instruments Limited plan to erect a new factory at Treforest.

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